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47

DESIGN MEMORANDUM NO. 3 MARCH 1977

MARYSVILLE LAKE
Yuba River, California

GENERAL DESIGN MEMORANDUM
PHASE I
PLAN FORMULATION
PRELIMINARY REPORT

Appendixes A-N

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DEFENSE TECHNICAL INFORMATION CENTER

Information for the Defense Community

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DESIGN MEMORANDUM NO. 3
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM - PHASE I

Plan Formulation
Preliminary Report

APPENDIXES

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX A - PERTINENT CORRESPONDENCE

APPENDIX A - PERTINENT CORRESPONDENCE

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Board of Supervisors

YUBA COUNTY CALIFORNIA

COURTHOUSE
215 Fifth Street
Marysville
California

(916) ~~743-6871~~
674-6461

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JIM MARTIN
Chairman
1014 Jay Street
Marysville, CA 95901

Second District
HAROLD J. "SAM" SPERBECK
Vice - Chairman
204 Fifth Street
Marysville, CA 95901

Third District
JIM PHARRIS
Post Office Box 597
Olivehurst, CA 95961

Fourth District
NEAL J. DENNY
10122 Oroville Highway
Marysville, CA 95901

Fifth District
ROY G. LANDERMAN
Post Office Box 66
Browns Valley, CA 95918

KARL A. COZAD
Clerk

December 15, 1976

Donald M. O'Shei, Colonel, CE
District Engineer
Department of the Army
Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Subject: Marysville Lake

Dear Colonel O'Shei:

County staff has reviewed the "Study of Operation Costs and Income Projections for Marysville Lake Recreation Facilities" prepared for the U.S. Army Corps of Engineers by Genge Environmental Consultants. The District Office of the Corps of Engineers is commended for authorizing preparation and distribution of the report.

During the regular meeting of December 14, 1976, the Board discussed the feasibility of (a) operating a major recreational facility and (b) proposed public access points to the Yuba River. The following represents the consensus of the Board with respect to these two matters.

(a) <u>A Major Recreational Facility</u>: Due to financial constraints, the County is not interested in operating the recreational facilities. It is the Board's understanding that there are existing State and Federal agencies adequately funded and staffed which have experience in operating facilities of this type.

However, if new information is presented which indicates that local sponsorship of recreational facilities is of such importance that construction of the dam hinges on this factor, the County will certainly reconsider its position.

(b) Public Access Points to the Yuba River: The County would be interested in sponsoring such facilities. This interest is based on the anticipation that various grant funds will be available for initial development.

Please do not hesitate to contact me if you desire further information.

Sincerely,

Jim Martin

Jim Martin, Chairman
Yuba County Board of Supervisors

ps

cc: Donald R. Frost
Director of Public Works

Board of Supervisors

COURTHOUSE

215 Fifth Street

MARYSVILLE
CALIFORNIA 95901

(916) 674-6461

JIM PHARRIS, Chairman
Third District

JIM MARTIN, Vice-Chairman
First District

HAROLD J. "SAM" SPERBECK
Second District

DOUG WALTZ
Fourth District

ROY G. LANDERMAN
Fifth District

KARL A. COZAD
County Clerk

THOMAS W. SHERRY
Administrative Assistant
(916) 674-6464

March 1, 1977

Colonel Donald M. O'Shei, District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel O'Shei:

The Board of Supervisors wishes at this time to express its support for the Marysville Lake Project, which is being considered for construction by the Corps of Engineers at the Parks Bar site. We urge that construction proceed at the earliest possible date.

We strongly desire development of the recreation access sites along lower Yuba River and we wish to express our intent to accomplish or cause to be accomplished the following items, in accordance with requirements of the Federal Water Project Recreation Act (PL 89-72):

(a) Administer the lower Yuba River public access points for recreation;

(b) Pay, contribute in kind, or repay with interest one-half of the separable cost for recreation, the non-Federal share currently estimated at $227,000 for the initial four sites, and $145,000 additional to bring all six sites to ultimate capacity;

(c) Bear all costs of operation, maintenance and replacement of the lower Yuba River recreation access sites, currently estimated to be $25,000 in 1990, and $75,000 in 2090, on an average annual basis.

We have reviewed a draft contract describing our obligations for the recreation sites, and we would be willing to enter into such a written agreement with the United States at the appropriate time.

Additionally, we wish to express our intent to prevent future encroachments on those non-Federal lands along lower Yuba River designated by the California Reclamation Board as Floodway Area A.

As indicated in the Board's letter to you dated December 15, 1976, the County does not wish to participate in operation of recreation facilities at the lake. However, if new information is presented which indicates that local sponsorship of recreation facilities is of such importance that construction of the dam hinges on this factor, the County will certainly reconsider its position.

Sincerely,

Jim Pharris

Jim Pharris, Chairman
Yuba County Board of Supervisors

JP:DF:ps

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX B - REPORTS OF OTHER AGENCIES

APPENDIX B - REPORTS OF OTHER AGENCIES

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United States Department of the Interior

BUREAU OF RECLAMATION

MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY
REFER TO: MP-700
125.1

APR 2 1976

District Engineer
Department of the Army
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

Your letter of February 27, 1976, requested our agency to perform operations studies and benefit computations for the authorized Marysville Lake Project, California. You also requested detailed supporting data on the need for Marysville Project yield for the CVP, timing for marketability of the yield and a discussion of implications of using the yield for improving water quality in the Sacramento-San Joaquin Delta. The operations data will be forwarded to you upon completion. Discussion of CVP need of Marysville yield and related matters follows.

I have enclosed a copy of Working Document No. 4, January 1975, of our CVP Total Water Management Study. Table 9, pages 47-50 of this document shows a water supply availability of 11.4 million acre-feet (including a 155,000 acre-foot Marysville Unit), supply already contracted of 9.1 million acre-feet and an anticipated demand for CVP water of 10.8 million acre-feet. The Mid-Valley Canal being planned for 1985 service to partially stem overdraft conditions on the east side of the San Joaquin Valley would require another 650,000 acre-feet, making the anticipated demand for CVP water 11.5 million acre-feet.

Computation of the water supplies available to the CVP was based on a Delta outflow of 1,800 ft^3/s which, with the proposed Peripheral Canal in operation, was deemed sufficient to meet Delta criteria agreed to by representatives of Delta water user groups and shown on Table 8, page 31 of the Working Document as the November 19, 1965 criteria. Current analysis of flow and water quality data for the Delta indicates that the Delta outflow should be increased to 2,500 ft^3/s to meet November 19, 1965 criteria. On an annual basis this flow increase of 700 ft^3/s would require about 300,000 acre-feet to meet the CVP share of outflow. Since this would place additional demands on developed CVP water supplies, the anticipated demand for CVP water would be increased by 300,000 acre-feet to 11.8 million acre-feet.

Different assumptions as to Delta water quality to be maintained other than November 19, 1965 criteria and cross-Delta conveyance facilities other than the Peripheral Canal would further affect CVP water supply versus demand computations. For example, meeting the outflow requirements of the California Water Resources Control Board's (SWRCB) Decision 1379 -- if it were applicable to CVP operations -- without a proposed Peripheral Canal and without overland water supply facilities for the western Delta would increase demand on CVP yield by another 2.2 million acre-feet. Therefore, meeting D-1379 criteria in the Delta would increase the anticipated demand for CVP water by 2.2 million acre-feet to 14.0 million acre-feet versus a developed CVP water supply of 11.4 million acre-feet. As you can see, meeting anticipated water demands including D-1379 (without any dry-year relaxation -- to be considered beginning in April 1976 by SWRCB) would require some 2.6 million acre-feet in additional CVP water supply development.

In addition to contracts included within the 9.1 million acre-feet CVP supply under long-term contract, shown in Table 9 of Working Document No. 4, we have recently contracted with Cross-Valley Canal interests for 128,000 acre-feet; are nearing completion of negotiations with the Santa Clara Valley Water District for a portion of the San Felipe service (152,500 acre-feet which will be limited to 137,500 acre-feet if reclaimed wastewater proves feasible by 1990); are negotiating for 43,800 acre-feet of San Felipe supply to San Benito County; have reserved 20,000 acre-feet of San Felipe service until 1990 for possible use by the Watsonville area and/or Monterey County; are negotiating with California Department of Water Resources for up to 300,000 acre-feet of interim water sales (1976 to 2000 with quantity adjustable every 5 years); and the Westlands Water District and other San Joaquin Valley water users are presently purchasing some 250,000 acre-feet of water annually in excess of the long-term unit supply.

The enclosed map, Exhibit A to the May 16, 1960 agreement between the DWR and our agency, shows generally the area designated as CVP service by that agreement. As you may be aware, the eastern San Joaquin Valley is presently experiencing a ground-water overdraft of from 1 to 1.5 million acre-feet annually. Our agency is constructing the Folsom South Canal (895,000 acre-feet) to serve the more northerly portion of the eastern San Joaquin Valley. We had planned the East Side Unit to serve the balance of the overdraft area, but this plan was not acceptable to the State of California. We are presently engaged in a joint study with the DWR of the feasibility of a Mid-Valley Canal (1985 - 500,000 acre-feet; 1990 - 650,000 acre-feet) for service to the eastern San Joaquin Valley.

I believe that the above discussion and the enclosed material adequately reflects the fact that the yield of the Marysville Unit can be used for meeting CVP water service demands as soon as the unit can be constructed.

Insofar as using Marysville Project yield for Delta water quality, we would integrate the Marysville Project yield into the Central Valley Project yield. Therefore, any water quality criteria required to be met by the CVP would impact on total CVP yield and not the Marysville Project yield *per se*.

On reflection of events pertinent to Delta water quality criteria, it is apparent that prediction of criteria that will be in effect at the time Marysville Project becomes operational is difficult, if not impossible.

Decision 1379 of the SWRCB contained quality criteria that were interim in nature (reconsideration provided for by, or before, 1978) and were subject to relaxation upon construction of substitute water supply facilities in the Delta. Decision 1379 was never implemented for the Federal Project because of a lawsuit brought by San Joaquin Valley water users.

Basin Plans and quality criteria contained therein were prepared by SWRCB pursuant to provisions of PL 92-500. Water quality criteria proposed for the Central Valley and San Francisco Bay area have been approved by the EPA. As per PL 92-500, the plans may be revised periodically as new data becomes available.

SWRCB plans hearings on dry-year water quality criteria for the Delta and Suisun Marsh which could alter present quality criteria developed for these areas and adopted by EPA.

The Bureau of Reclamation and DWR are negotiating water service contracts with Delta agricultural water users which would state the quality of water required to meet their needs. These contract quality criteria should impact on the determination of Delta quality of water criteria for agriculture to be maintained by enforcement provisions of EPA and SWRCB.

The Bureau, DWR, California Department of Fish and Game, and the U.S. Fish and Wildlife Service have been engaged for several years in Four-Agency ecological studies of the Sacramento-San Joaquin Delta, an objective of which is to determine water quality conditions required for protection of Delta fish resources under future conditions of cross-Delta water conveyance. Data generated by this study will further define Delta water quality criteria.

Also, lawsuits and/or appeals of judicial decisions with respect to SWRCB Decisions 1379, 1400 and 1422 will impact on water quality criteria to be maintained as a responsibility of CVP operations.

In summary, we believe that we could integrate water supply of the Marysville Project into the Central Valley Project yield for meeting water quality and water supply obligations of the CVP as soon as you can complete construction of the project.

Sincerely yours,

B. E. Martin

B. E. Martin
Regional Director

Enclosures

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
2800 Cottage Way, Room E-2727
Sacramento, California 95825

May 13, 1976

District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

This is in response to your request of October 22, 1975 that our office provide a planning aid letter covering mitigation measures and justification thereof for the Parks Bar site of the Marysville Lake Project. Identified in this letter are the major potential impacts of the project on fish and wildlife resources and measures that would be needed to minimize or offset the impacts. Personnel of the California Department of Fish and Game have reviewed our recommendations for mitigation and have informed us by letter of the Department's general concurrence. All cost estimates given are for mitigation measures and are considered to be a project responsibility. The project provides some opportunities for the enhancement of fish and wildlife resources, and we plan to provide that information at a later date. This analysis takes into account additional project information provided by the Corps since our preliminary report of October 22, 1974 and is provided at this time to aid in your plan formulation and preparation of the draft environmental impact statement.

With respect to flow releases from Parks Bar Reservoir, our analysis is based on the assumption that the following temperature and volume parameters would be met at the mouth of the Yuba River:

Temperature (maximum)		Flow[1/] (minimum)	
1 Oct. - 15 Oct.	60°F	Oct. - Jan.	800 cfs
15 Oct. - 31 Mar.	55°F	Feb. - Apr.	1,000 cfs
1 Apr. - 15 May	60°F	May	800 cfs
16 May - 31 May	65°F	June - Sept.	600 cfs
1 June - 15 June	70°F		
16 June - 15 Sept.	72°F		
16 Sept.- 30 Sept.	70°F		

1/ Minimum flows for February, March and April are higher than specified for those months in your letter of May 23, 1975. We are reluctant to endorse a minimum flow less than 1,000 cfs in view of the existing flow regime and the importance of spring flushing to downstream migrant salmon.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

A dam and reservoir at the Parks Bar site would cause major changes in fish and wildlife populations. The project would render unusable a 9-mile river stretch important to anadromous fish for spawning and rearing. Habitat for resident and migratory deer, upland game, waterfowl, furbearers, and non-game birds and mammals would be inundated. Certain project modifications would be necessary to prevent avoidable damages to fish and wildlife and other separate features would be required to offset unavoidable damages to fish and wildlife.

FISH MITIGATION MEASURES

To compensate for the loss of salmon and steelhead spawning and nursery habitat upstream from Parks Bar Afterbay, a hatchery should be constructed at a suitable site downstream from the afterbay. The hatchery should be sized to rear the numbers of smolts listed below in order to return 6,000 chinook salmon and 2,000 steelhead trout to the river each year.

	Salmon	Steelhead
Eggs Incubated	4,285,714	400,000
Smolts Released	3,428,571	200,000
Pounds of Smolts	58,143	28,570
Smolts per Pound	60	7

A water supply of suitable quality would be required for hatchery operation. It must contain adequate dissolved oxygen and be free of turbidity, disease organisms, and heavy metals such as cadmium, copper, lead, and zinc. Satisfactory conditions could best be assured by installation of wells and a water reuse system incorporating means for aeration, ammonia reduction, filtration, sterilization, and temperature control (50° - 57°F). Treatment of wastewater discharged from the hatchery to the Yuba River would be required.

The hatchery should be operational before instream construction of the dam begins. Also, if it is determined following a reasonable period of operation that the hatchery is not maintaining runs of 6,000 fall chinook and 2,000 steelhead, then it should be expanded or other appropriate corrective action taken at project cost. Determinations concerning required ancillary facilities (such as a barrier dam and fish ladder, or a trap and haul system) to route salmon and steelhead to the hatchery have not been made.

The Fish and Wildlife Service, in cooperation with the California Department of Fish and Game, will provide design criteria for the hatchery and ancillary facilities at such time as your planning schedule indicates the need for same. The estimated capital cost of a hatchery sized to produce the above numbers of smolts is $4,700,000--exclusive of any extraordinary costs for site preparation. The annual operation, maintenance, and replacement cost

would be about $220,000. Project funds for operation, maintenance, and replacement of the hatchery and ancillary facilities should be made available to the Fish and Wildlife Service. The California Department of Fish and Game would operate the hatchery facilities under a contract with the Fish and Wildlife Service. Title to lands and structures should remain vested in the Federal government.

Multilevel intakes to the outlet structure at Parks Bar Dam would be required to provide water of suitable temperature for maintenance of stream habitat downstream from the afterbay dam. Design and operational criteria for the outlet works should be developed by the Corps of Engineers in coordination with the Fish and Wildlife Service and the California Department of Fish and Game.

An annual release of 566,000 acre-feet of water, measured at the Yuba's confluence with the Feather, would be required to maintain fishery resources and stream habitat in the Yuba River. That volume of water should be "set aside" each year with complete operational flexibility to modify the flow schedule previously stated. The flow schedule should be jointly planned by the Fish and Wildlife Service, California Department of Fish and Game, and Corps of Engineers on an annual basis following spring and summer runoff forecasts.

Dry Creek Dam should be equipped with an outlet structure to provide a minimum year-round surface flow of 10 cfs, and occasional higher flows up to 100 cfs, down Dry Creek to its confluence with the Yuba. Such flows would maintain conditions for fish and wildlife below Dry Creek Dam, and possibly enhance stream conditions for steelhead.

A stream channel management program, in addition to water releases of suitable quantity and quality, would be required to preserve fish habitat downstream from Parks Bar Afterbay Dam and Dry Creek Dam. The program should include periodic removal of vegetation that has encroached into the channel, periodic riffle renovation, and gravel replenishment from the afterbay dam to Daguerre Point Dam. The average annual cost of the management program is estimated at $30,000. Annual plans for this work should be developed cooperatively by the Corps of Engineers, Fish and Wildlife Service, and the California Department of Fish and Game.

Protection of the Yuba's salmon and steelhead runs would depend upon three interdependent measures: a hatchery, suitable releases from Parks Bar Dam, and stream habitat management. An evaluation of these major endeavors would be required to ascertain whether the overall objective is being realized. A study for this purpose, lasting at least 4 years, should be initiated by the California Department of Fish and Game and the Fish and Wildlife Service as soon as the project is operational. The cost of the study, estimated at $62,000 annually, should be a project cost. The hatchery operation, downstream flow regime, and stream habitat management program would be adjusted in accordance with study findings.

WILDLIFE MITIGATION MEASURES

Highest deer density occurs in the foothill-woodland community: averaging 38 resident deer per square mile. The eight square miles of foothill-woodland habitat within the reservoir site therefore support about 300 deer year-round, or 110,000 deer-use days annually. Transect studies conducted by University of California personnel at the Sierra Field Station reveal an increase in deer numbers in the project area during late fall and winter. This annual increase is most likely due to ingress of deer from areas at higher elevations when weather conditions become unfavorable. During this period, densities reach about 107 deer per square mile on approximately 3 square miles of the foothill-woodland habitat and about 58 per square mile on the remaining 5 square miles of foothill-woodland range at the reservoir site. Thus, the resident population of 300 deer is augmented by about 300 migrants for 4 months in late fall and winter. Accordingly, total use of the reservoir site by deer is estimated at 150,000 use-days annually.

The amount of replacement habitat needed to offset deer losses would depend largely on its location and its present value to deer. In any case, the acreage required to compensate deer loss would be greater than the acreage lost because it is not possible with present management techniques to double the carrying capacity of habitat already supporting deer. For foothill-woodland habitat, we believe it is possible to increase carrying capacity by approximately one-third through intensive habitat management. On that basis, a management area of 14,900 acres would be required to replace habitat that would be inundated and that now is supporting 300 resident deer. It would also be necessary to offset the loss of habitat used by migratory deer. With intensive management, we estimate that the carrying capacity of range already supporting migratory deer could be increased by about one-fourth. On that basis, it would be necessary to acquire an additional 4,100 acres of foothill-woodland habitat. The total land requirement for deer mitigation purposes, using foothill-woodland habitat, would therefore be about 19,000 acres. About 7,000 acres within the takeline are considered to be suitable for wildlife mitigation purposes.

About 1,350 acres of excellent turkey wintering habitat, including a major roosting area, would be inundated. We believe that loss could be offset by the development of turkey habitat on lands acquired to mitigate losses to other wildlife species.

We are not yet able to recommend specific areas suitable for the mitigation of deer and turkey losses and cannot do so without additional study lasting at least 2 years. In our continuing investigation of this item we will consider locations within and adjacent to the project takeline. If this does not prove biologically feasible, "off-site" locations will be considered. The study should be conducted jointly by the California Department of Fish and Game and the Fish and Wildlife Service. Transfer funding in the amount of $26,000 annually will be required.

The streamside plant community is highly important to most species of wildlife inhabiting the project area. The loss of riparian habitat due to inundation would be severe, amounting to about 34 stream miles totalling 160 acres. The riparian community provides essential life requirements (food, water, and cover) to its inhabitants throughout the year. An additional amenity of the riparian community is the lower temperature regimen it affords animal life during the hot weather of late spring, summer, and early fall. Daily temperature readings in the project area over a 2-week period in late August and early September of 1975 showed a maximum of 96°F in riparian habitat and 114°F in adjacent foothill-woodland habitat. Moreover, the daily fluctuations between maximum and minimum temperatures were found to be significantly less in the riparian community. This more favorable temperature regimen, in conjunction with the higher humidity of the streamside environment and other characteristics, makes riparian areas vitally important to wildlife in the foothill regions of the Sacramento Valley. When riparian habitat is flooded, species that depend on it are lost because remaining riparian areas are generally being utilized to maximum carrying capacity. On the basis of field studies, we estimate that an annual loss of over 83,000 bird-use days would be caused by inundation of riparian habitat. More than 3,300 valley quail have been censused in riparian, foothill-woodland, and wet meadow habitat types at the reservoir site.

For the reason noted above, riparian losses cannot be offset through acquisition of established riparian areas. The only means of actually compensating wildlife losses resulting from inundation would be the creation of riparian habitat. We are giving consideration to a plan involving the supply of about 3,000 acre-feet annually to the Spenceville Wildlife Management Area where, with that amount of water provided during 6 months of the year, some 50 acres of riparian habitat could be created along intermittent stream courses. We believe that opportunities to offset the balance of the riparian loss exist on lands within the takeline, such as grassland areas draining into the reservoir basin and lands bordering Yuba River downstream from the afterbay dam.

The flood control that would be provided by a reservoir at Parks Bar would likely accelerate land use changes on the lower Yuba River and Dry Creek flood plains, directly affecting natural riparian areas in an adverse way. We would anticipate that the diminished frequency and volume of flood flows would foster the conversion of riparian forest to cropfields and orchards. To protect wildlife values, all riparian habitat along the lower Yuba River (both primary and secondary channels) and along Dry Creek from Dry Creek Dam to the mouth should be preserved through acquisition of fee title or environmental easement.

The project would cause a loss of about 300,000 waterfowl-use days, mainly associated with Duchel's Pond and surrounding agricultural land. To compensate for waterfowl losses, we recommend construction of ten 1-acre ponds in the grassland area immediately south of the proposed

afterbay dam. Water required to maintain pond levels during the dry season (estimated at 110 acre-feet per year) could be purchased from Nevada Irrigation District and conveyed by existing Farm Ditch or could be pumped from the afterbay and conveyed by pipeline. We estimate the cost of constructing dikes and water control structures, and of excavation and filling to attain desired slopes, at about $8,500. Annual operation, and maintenance would be about $1,500. Also, the management of about 8 acres of adjacent pasture to provide forage for geese would be required. Annual O & M cost for that item is estimated at $500. The foregoing cost estimates do not include the cost of any land acquisition required.

RECOMMENDATIONS

To mitigate fishery losses, we recommend that the project provide for:

1. A fish hatchery, together with facilities to transport fish from the river to the hatchery, to maintain an average annual run of 6,000 chinook salmon and 2,000 steelhead trout. The estimated capital cost of the hatchery alone, exclusive of any extraordinary cost for site preparation, is $4,700,000. The annual cost for hatchery operation, maintenance, and replacement is estimated at $220,000. Funds for operation, maintenance, and replacement of the hatchery and associated facilities should be made available annually by the Corps of Engineers to the Fish and Wildlife Service. The Fish and Wildlife Service would enter into a contract with the California Department of Fish and Game for operation of the fish hatchery and associated facilities. The hatchery and related facilities should be operational before initiating construction of other project features that would adversely affect anadromous fish.

2. A multilevel intake to the outlet structure at Parks Bar Dam to provide water of suitable quality to meet the criteria for river temperatures at the mouth of the Yuba, as set forth in this letter.

3. A release of 566,000 acre-feet of water annually from Parks Bar Reservoir (measured at the mouth of Yuba River) in accordance with the monthly schedule set forth in this letter, or such modification of that schedule as may be mutually agreed to by the Corps of Engineers, the California Department of Fish and Game, and the Fish and Wildlife Service.

4. $30,000 annually for stream management work between Parks Bar Afterbay Dam and the mouth of the Yuba River, with provision for accumulation of any unexpended portions of the annual allotment for use during years when extra work may be required.

5. A study of at least 4 years duration to determine the effectiveness of the hatchery, reservoir releases, and stream management

program in offsetting project caused anadromous fish losses. Modifications in hatchery operation, reservoir releases, and stream management program would be made in accordance with study results. Cost of the study is estimated at $62,000 annually.

6. A minimum year-round surface flow of 10 cfs, and occasional flow up to 100 cfs, in Dry Creek from Dry Creek Dam to its confluence with the Yuba River.

To mitigate wildlife losses, we recommend that the project provide for:

1. Acquisition of at least 19,000 acres of land to replace deer and turkey range. Studies to determine the locations of mitigation tracts and development required to raise their carrying capacity will require transfer funding of $52,000. The replacement habitat would be administered by the California Department of Fish and Game.

2. Development of 160 acres (or 34 miles) of riparian lands to be selected by the Fish and Wildlife Service and the California Department of Fish and Game. Riparian vegetation would be established in accordance with a plan developed jointly by the Corps of Engineers, the Fish and Wildlife Service and the California Department of Fish and Game. Part of the requirement could be met by supplying 3,000 acre-feet of water to the Spenceville Wildlife Management Area.

3. Acquisition of a corridor approximately 1,500 feet wide to encompass all riparian vegetation along Dry Creek from Dry Creek Dam to the creek mouth and along the lower Yuba River from Parks Bar Afterbay Dam to near the Yuba's confluence with the Feather River.

4. Construction of ten 1-acre ponds and management of 8 acres of adjacent pastureland to provide marsh habitat and feeding area for waterfowl. Costs for initial development and annual operation and maintenance are estimated at $8,500 and $2,000, respectively.

Please notify us of your proposed actions regarding our recommendations.

Sincerely,

Felix E. Smith

Felix E. Smith
Field Supervisor

cc: Dir., CDF&G, Sacto
Reg. Mgr., Reg. 2, CDF&G, Sacto
NMFS, Tiburon
RD (ES), USFWS, Portland

FEDERAL POWER COMMISSION
REGIONAL OFFICE
U. S. CUSTOM HOUSE
SAN FRANCISCO, CA. 94111

July 16, 1976

Code	Action	Surname & Date

Gordon R. Estes, Regional Supervisor of Power
Mid-Pacific Region
Bureau of Reclamation
2800 Cottage Way
Sacramento, CA 95825

Dear Mr. Estes:

The following is in response to the request for power values in your letter of May 26, 1976.

The attached tables show our estimates of hydroelectric power values for FPC Power Supply Area 46 based on January 1, 1976 price levels for a complete range of capacity factors from 1 to 90%. As requested, the power values were computed for federal financing using 3-1/4% and 6-1/8% interest rates, and for composite financing based on 80% private and 20% public-nonfederal financing. A 10% cost of money was assumed for private financing and 6-3/4% rate of interest was used for public-nonfederal financing.

As before, the power values are at-market, include the hydro-thermal capacity and energy value adjustments, and are based on the estimated costs of the three alternative sources described below.

(1) Nuclear-fired steam-electric plant with 2000 MW total capacity consisting of two 1000 MW units operating at a 65% average annual capacity factor; heat rate, 10,500 Btu/kWh; capital cost, \$570 per kilowatt; service life, 30 years; fuel inventory, \$50 per kilowatt; and fuel energy cost, 3.0 mills per kilowatthour.

(2) Combined cycle generating plant with 710 MW total capacity consisting of two 355 MW units, four combustion turbines and one steam turbine per unit operating at a 25% average annual capacity factor; heat rate, 9000 Btu/kWh; capital cost, \$250 per kilowatt; service life, 30 years; and low sulfur oil cost of \$2.25 per million Btu.

(3) Combustion turbine generating plant with 568 MW total capacity consisting of four 142 MW units operating at a 7.5% average

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

annual capacity factor; heat rate, 13,000 Btu/kWh; capital cost, $135 per kilowatt; service life, 30 years and low sulfur oil cost of $2.25 per million Btu.

Your letter also requests off-peak pumping energy costs which we estimate to be 17.18 mills/kWh as of January 1, 1976. As noted previously, after 1990 nuclear-fired generating plants will be the probable source of pumping energy. Our estimate, also based on January 1, 1976 costs, is 3.24 mills/kWh for this energy.

Very truly yours,

M. Frank Thomas

M. Frank Thomas
Regional Engineer

Attachments: 3 tables

PSA 46

Hydroelectric Power Plant Power Values At Market
(Costs as of 1/1/76)

Federal Financing - 6-1/8% Interest

Hydro Plant Annual Capacity Factor	Nuclear Steam-electric 1/	
	Capacity	Energy
%	$/kW-yr.	mills/kWh
1.0	17.76	3.16
2.5	18.81	"
5.0	20.56	"
7.5	22.31	"
10.0	24.06	"
12.5	25.82	"
15.0	27.57	"
17.5	29.32	"
20.0	31.07	"
25.0	34.58	"
30.0	38.08	"
35.0	41.58	"
40.0	45.09	"
45.0	48.59	"
50.0	52.10	"
60.0	59.10	"
70.0	66.11	"
80.0	73.12	"
90.0	80.13	"

1/ Energy value adjustment applied to capacity value.

PSA 46

Hydroelectric Power Plant Power Values At Market
(Costs as of 1/1/76)

Federal Financing - 3-1/4% Interest

Hydro Plant Annual Capacity Factor	Nuclear Steam-electric 1/	
	Capacity	Energy
%	$/kW-yr.	mills/kWh
1.0	9.87	3.16
2.5	10.74	"
5.0	12.18	"
7.5	13.63	"
10.0	15.07	"
12.5	16.51	"
15.0	17.96	"
17.5	19.40	"
20.0	20.84	"
25.0	23.73	"
30.0	26.61	"
35.0	29.50	"
40.0	32.39	"
45.0	35.27	"
50.0	38.16	"
60.0	43.93	"
70.0	49.70	"
80.0	55.48	"
90.0	61.25	"

1/ Energy value adjustment applied to capacity value.

PSA 46

Hydroelectric Power Plant Power Values At Market
(Costs as of 1/1/76)

Composite Financing 1/

Hydro Plant Annual Capacity Factor	Combustion Turbine 2/		Nuclear Steam-electric 2/	
	Capacity	Energy	Capacity	Energy
%	$/kW-yr.	mills/kWh	$/kW-yr.	mills/kWh
1.0	26.89	97.81		
2.5	"	51.91		
5.0	"	36.61		
7.5	"	31.51		
10.0	"	28.97		
12.5	"	27.44		
15.0	"	26.42		
17.5	"	25.69		
20.0	"	25.15		
25.0			71.25	3.16
30.0			75.37	"
35.0			79.49	"
40.0			83.61	"
45.0			87.73	"
50.0			91.84	"
60.0			100.07	"
70.0			108.32	"
80.0			116.55	"
90.0			124.79	"

1/ 80% private financing @ 10%, and 20% public-nonfederal @ 6.75%.

2/ Energy value adjustment applied to energy value of the combustion turbine and to the capacity value of the nuclear steam-electric.

FEDERAL POWER COMMISSION
REGIONAL OFFICE
U. S. CUSTOM HOUSE
SAN FRANCISCO, CA. 94111

July 26, 1976

Colonel Donald M. O'Shei
District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel O'Shei:

We have reviewed the report "Powerplant Sizing Study, Marysville Lake Project", dated May 1976, which was prepared by the U. S. Bureau of Reclamation and transmitted by Colonel Rockwell's letter of June 3, 1976. His letter requests that we analyze the operation and power facilities optimization studies contained in the report and perform a load study to determine the need and timing for pumped storage hydropower from the project.

The USBR report indicates that the proposed 900 MW pumped storage development would go into service in 1990. The report also indicates that the reservoir would not attain adequate storage to develop its full potential for firm generation until 1993. We have therefore only credited the project with energy benefits until 1993. Our load study shows that the critical year peaking capability of 900 MW would be usable and dependable in 1993 and thereafter in the Northern California load. This is essentially equivalent to FPC Power Supply Area 46.

Our economic analysis of the proposed power facilities for a 900 MW pumped storage development at the Marysville Lake Project is based on January 1975 price levels, a 100-year amortization period, and a 3 1/4 percent interest rate. Our analysis shows that the benefit-cost ratio for the proposed power facilities would be 2.55 and that the incremental benefit-cost ratio between a 750 MW installation and a 900 MW installation would be 1.97.

We therefore conclude that based on the power operation studies and cost estimates presented in the USBR report, that a 900 MW pumped storage development at the Marysville project would be economically justified, and usable and dependable on the Northern California load by 1993.

Sincerely,

M. Frank Thomas

M. FRANK THOMAS
Regional Engineer

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

FEDERAL POWER COMMISSION
REGIONAL OFFICE
U. S. CUSTOM HOUSE
SAN FRANCISCO, CA. 94111

August 24, 1976

Colonel Donald M. O'Shei
District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel O'Shei:

At the request of James B. Smith of your office, we are sending you information to supplement that in our letter of July 26, 1976 concerning our dependable capacity study of the proposed Marysville Lake Project.

Estimated loads used in the study are from those developed for the Western Systems Coordinating Council (WSCC) and shown in its "Reply to Federal Power Commission Docket R-362, Order 383-3," dated April 1, 1976. The study area is the "Pacific Southwest Power Area, Sub-Area D," which approximates the Federal Power Commission's Power Supply Area 46. The following tabulation shows the estimated loads covering the period in which the Marysville Lake project will probably be completed.

Estimated Annual Load Requirements

Year	Peak Demand MW	Energy GWh
1990 1/	31 000	161 800
1	32 500	169 700
2	34 200	177 900
3	35 900	186 600
4	37 600	195 700
5 1/	39 500	205 200

1/ Obtained from WSCC-intervening years by interpolation

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Resources used in the study are from the WSCC report, "Summary of Estimated Loads and Resources," dated April 1976. Additional information was obtained from individual utilities as needed. Firm contracts expected to be in existence in the 1990-1995 period are included.

Our study shows that August is the probable month of peak demand and also the critical supply month for 1993, the assumed first full year of operation of the proposed project. For our study, reserve allowances of 20 percent of peak demand and 5 percent of energy needs were added to the requirements in order to represent the total loads to be met by the available supply in the critical month of August. Project pumping requirements also were added to the monthly energy requirements. The proposed project's critical year outputs by months as well as monthly pumping energy requirements used in our study are those which were provided in Exhibit F, USBR, Powerplant Sizing Study (May 1976) for the Marysville Lake Project.

Comparison of estimated loads and resources for 1993 shows a need for additional system peaking capability. The proposed Marysville Lake Project with its 900 MW peaking capability and 88 GWh energy output can dependably supply a portion of this required additional capability.

Very truly yours,

M. Frank Thomas

M. Frank Thomas
Regional Engineer

United States Department of the Interior

BUREAU OF RECLAMATION

MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY
REFER TO: MP-621
651.

NOV 1 2 1976

Mr. H. Frank Thomas
Regional Engineer
Federal Power Commission
555 Battery Street, Room 415
San Francisco, CA 94111

Dear Mr. Thomas:

This letter is pursuant to discussions between your staff, the Corps of Engineers, and my staff at the November 10, 1976 meeting regarding the application of energy adjustments to power values. For our better understanding of the adjustment process, we are hereby requesting the back-up data to the power values furnished in your letter to Mr. Estes dated May 26, 1976.

We understand from discussions with your staff that the power values furnished in your May 26, 1976 letter were based on the most economic of the following alternative powerplants.

a. Combustion Turbine

b. Combined Cycle

c. Nuclear Steam-electric

Please include with your back-up data the analysis of each of the above alternatives based on (a) private financing at 10 percent interest, (b) public-nonfederal financing at 6-3/4 percent, (c) Federal financing at 6-1/8 percent and (d) Federal financing at 3-1/4 percent interest.

We would appreciate receiving the requested data as soon as possible.

Sincerely yours,

John W. Anderson

John W. Anderson
Acting Regional Supervisor of Power

B-20

Copy to: Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

B-21

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
2800 Cottage Way, Room E-2727
Sacramento, California 95825

December 21, 1976

District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

This supplements and amends our May 13, 1976 letter which dealt with mitigation measures for fish and wildlife with respect to the Parks Bar site of the Marysville Lake Project. In addition, this letter discusses possible enhancement measures for the project and the associated benefits.

This planning aid letter has been prepared under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Our conclusions are concurred in by the California Department of Fish and Game as indicated by the attached letter of December 14, 1976 from Director E.C. Fullerton.

FISH MITIGATION MEASURES

For chinook salmon, our previous recommendation for sizing of the mitigation hatchery was based on rearing progeny only to smolt size (60 per pound). On reconsideration, we now believe that chinook -- as with steelhead trout -- should be held in the hatchery until they attain yearling size (10 per pound). Accordingly, incubation facilities for chinook should be sized to accommodate 375,000 eggs. From that number of eggs it can be expected that 300,000 salmon would be available for release as yearlings. This change would lower the capital cost of the hatchery from \$4,700,000 to \$3,200,00 and the annual operation, maintenance, and replacement cost from \$220,000 to \$160,000 because of reduced water and rearing pond requirements. It appears that the most favorable location for the hatchery is on the right bank of the Yuba River immediately below Daguerre Point Dam.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Our recommendations concerning steelhead trout have been based on the assumption that the Yuba River system supports an average annual run of 2,000 spawners. Because there is reason to believe that the estimate may be too low, the California Department of Fish and Game and the Service are jointly conducting a trapping-marking-recapture study in the lower Yuba this season.

In addition to anadromous species, the project would impact warmwater species and "resident" trout (i.e., non-migrant steelhead and other trout) inhabiting the reach of the Yuba River that would be inundated. About 75 percent of the angler use of the "resident" trout fishery would be lost. However, that loss would be recovered by reason of improved access to the river (especially between Daguerre Point Dam and Parks Bar Afterbay) that would be realized through your plan for establishment of a Lower Yuba environmental corridor.

A warmwater sport fishery would develop in Parks Bar Reservoir from fish stocks present in the reach of the Yuba River that would be inundated and in Englebright Reservoir which also would be inundated by the new reservoir (due to the severity and timing of drawdowns, the afterbay would sustain a fishery of only minor importance). Loss of the existing angler use of the warmwater fishery -- calculated at 29,700 angler days on an average annual basis in the area that would be inundated -- would be recovered at the new reservoir if use facilities were provided. Parking, sanitation and boat launching facilities to accommodate anglers from years 1 through 50 could be provided at an estimated capital cost of $49,000 and annual OM&R cost of $7,400. By year 50, it would be necessary to provide additional facilities costing an estimated $72,000 for capital investment and $9,100 for annual OM&R.

WILDLIFE MITIGATION MEASURES

As indicated in our May 13 letter, we believe that a substantial acreage of foothill-woodland habitat should be acquired and developed for deer mitigation purposes. We have used deer as the key species in our analysis of project impacts on wildlife and have assumed that a development plan designed primarily for deer will benefit upland game as well. The land acquisition and development program should be planned with the following concepts in mind:

1. Acquisition in large blocks to facilitate administration by the managing agency and to optimize opportunities for best location of habitat improvements.

2. Implementation of mitigation measures prior to and during project construction -- it usually takes two to three years

for permanent pasture to become established; five to ten years, or more, for browse restoration to reach peak production.

3. Within acquired tracts, areas having the best soils and least slopes should receive priority consideration for habitat development (irrigated pasture, ponds, and browse).

4. Certain habitat improvement practices, such as prescribed burning, seeding, fertilizing, and brush manipulation, must be repeated periodically (3-5 years).

As a result of our continuing study of project impacts and of potentially available replacement habitat, it now appears that there would be some 11,800 acres of land suitable for wildlife mitigation within the project takeline. Additionally, about 1,000 acres of project land would be available for wildlife purposes until year 50 when its development for general recreational use is planned. Most of these lands are presently providing good habitat and cannot generally be improved for wildlife except through a reduction in livestock grazing. It is believed that the wildlife carrying capacity of project lands could be increased by about ten percent by limiting grazing to a level compatible with wildlife management.

Additional wildlife mitigation could be accomplished on land outside the takeline at Spenceville Wildlife Management Area by providing irrigation service to about 1,000 acres of grassland in numerous parcels. The overall carrying capacity of the 11,000-acre Spenceville WMA could thereby be increased by about 20 percent, at an estimated capital cost of $240,000 and an annual operation and maintenance cost of $80,000.

By making maximum use of lands already in public ownership and of lands that will be acquired for primary project purposes, it is possible to reduce acquisition exclusively for wildlife mitigation to about 8,000 acres. Suitable lands occur in two locations proximate to the project: (1) between the proposed project takeline and Spenceville WMA, in particular parts of sections 4, 5, 32, 33, and 34 (T. 15 and 16N, R. 6E), and (2) the Hackett Creek and other areas within the old "Camp Beale Military Reservation" adjoining the eastern boundary of the Spenceville WMA. About 6,000 acres at these locations could be intensively developed for wildlife by crushing, burning, irrigating, fertilizing and seeding for an average cost of about $120 per acre. Additionally, construction of as many as 24 small ponds could be accomplished at an estimated cost of $72,000. Total initial costs for wildlife mitigation in areas (1) and (2), not including land acquisition, would therefore be about $800,000. The annual operation, maintenance, and replacement cost would be about $150,000. Additional habitat mitigation could be accomplished through the joint mitigation-enhancement measure described later.

FISH ENHANCEMENT MEASURES

The salmon and steelhead resource in the Yuba River could be enhanced by enlarging the hatchery that is required for mitigation. Annual release of hatchery-reared yearlings at the levels listed below would support an average annual return to the river of 50,000 chinook salmon and 10,000 steelhead trout.

	salmon	steelhead
Eggs Incubated	3,125,000	2,000,000
Yearlings Released	2,500,000	1,000,000
pounds of yearlings	250,000	142,857
yearlings per pound	10	7

The estimated capital cost of enlarging the hatchery beyond the mitigation level to produce these additional yearlings is $22,600,000, exclusive of any extraordinary costs for site preparation. The annual operation, maintenance, and replacement cost would be about $1,150,000.

Average annual visitation by the public to the hatchery would be 206,600 visitor days based on the following expected trend. This level of use would occur as well at a hatchery sized for mitigation only.

Visitor Days 1/

Year	Visits
Initial	95,000
50th	182,000
100th	364,000

1/ Trends between years shown are straight lines. Each visitor day is valued at $0.75.

Estimated capital cost of visitor facilities needed to accommodate this use level is $81,000. Annual operation, maintenance, and replacement cost would be $13,000.

Given the foregoing releases of anadromous fish, a sport fishery benefit amounting to 185,000 angler days on an average annual basis could be realized -- assuming an improvement in angler access and liberalization of present restrictions on salmon fishing. The provision of angler access should be compatible with your plan to establish an environmental corridor along the lower Yuba. As a minimum, public access to the river should be provided at the afterbay dam, above and below Daguerre

Point Dam, at Walnut Avenue, and at the mouth of the river. In addition to the sport fishery benefit, the ocean commercial catch of salmon should be increased by about 1,155,000 pounds annually, presently valued at $1.50 per pound.

We believe that all costs, initial and recurrent, associated with enlargement of the hatchery and provision of angler access should be considered non-reimbursable Federal costs because of the migratory nature of the fishery resource benefited.

Establishment of a lower Yuba River corridor (a mitigation feature) with provisions for public access would coincidentally benefit the American shad, striped bass, and "resident" trout fisheries. Average annual use attributable to the corridor with access would amount to 10,500 angler days for American shad, 3,000 angler days for striped bass, and 2,550 angler days for "resident" trout.

At the Corps of Engineers' request, we evaluated the proposal to develop a secondary channel downstream from the afterbay site for possible salmon enhancement. We believe that only a minor benefit would result from such development because a secondary channel would provide additional spawning and rearing habitat only during years of above normal runoff. Given that condition, we estimate that each acre of the secondary channel would increase sport fishing by 20 angler days and the commercial harvest by 462 pounds on an average annual basis.

A coldwater sport fishery could be developed in Parks Bar Reservoir by annually stocking catchable-size rainbow trout and possibly other salmonid fishes. An improved and largely self-sustaining warmwater sport fishery could also be developed by infrequent stockings beginning the first year of reservoir storage. Parks Bar Reservoir -- with stocking of both coldwater and warmwater species and with provision of angler access and related facilities beyond the level required for mitigation alone -- would support an additional average annual use of 28,600 angler days. Because Parks Bar Reservoir would draw anglers away from nearby reservoirs (New Bullards Bar, Merle Collins, Camp Far West, Oroville) only 3/4 of these angler days should be claimed as a benefit attributable to Parks Bar.

Capital cost for hatchery facilities to produce the required number of rainbow trout for annual stocking (74,000) would be about $60,000 if the proposed anadromous fish hatchery were expanded. The annual cost for hatchery operation, maintenance, and replacement, including fish distribution, would be about $19,000. Warmwater species required for initial stocking could be secured from the California Department of Fish and Game or from a private source at a cost of about $6,750. Capital costs for parking, sanitation, and boat launching facilities to accommodate an additional average annual use of 28,600 angler days

would be approximately $42,000 initially and $74,000 by year 50. The annual costs for operation, maintenance, and replacement are estimated at $3,500 for years one through 50 and $6,700 for years 51 through 100. All costs associated with this enhancement feature would be subject to the cost sharing provisions of the Federal Water Project Recreation Act (P.L. 89-72, as amended).

JOINT MITIGATION-ENHANCEMENT

MEASURE

FOR FISH AND WILDLIFE

Our May 13 letter contains a recommendation that waterfowl losses attributable to the project be mitigated by the construction of ten 1-acre ponds and management of 8 acres of pasture in the grassland area south of the afterbay dam. In conjunction with that recommendation for waterfowl mitigation, it would be possible through further development in the vicinity to provide waterfowl enhancement and concomitantly replace some of the riparian habitat lost as a result of the project. As many as 60 impoundments, varying in size from one to 140 acres, could be developed on intermittent drainages within the grassland area by supplementing natural runoff with project water. Implementation of this joint mitigation-enhancement measure would establish about 460 acres of permanent freshwater marsh and permit growth of about 50 acres of riparian habitat. Such marshes constitute important production areas for waterfowl as well as feeding and resting places for birds in migration. Based on counts of bird use at Duchel's Pond, the freshwater marsh habitat created under this feature would support 4,000,000 waterfowl use days during the migration period. Other groups of migratory birds, e.g., shorebirds and wading birds, would also utilize the new habitat.

Acquisition of 1,200 acres of privately owned land together with permission to develop about 300 acres within Beale Air Force Base would be required for full implementation of this mitigation-enhancement feature. Water for maintenance of pond levels during the dry season (estimated at 4,720 acre-feet per year) could be acquired by purchase from Nevada Irrigation District, with conveyance by Farm Ditch, and by diversion from the Yuba River by means of Yuba River Ditch, located just below the proposed afterbay dam. We have not determined land acquisition costs; however, the capital costs for dike construction, water control devices, extension and renovation of ditches, and fencing, would total approximately $228,000. These cost estimates include those given in our previous letter with respect to the mitigation plan: ten 1-acre ponds and 8 acres of pasture. The annual operation,

maintenance, and replacement cost would be $34,000. In view of the fact that the wildlife enhancement resulting from this feature would accrue predominantly to the migratory bird resource (for which the Federal government has a primary management responsibility), and because the feature would concomitantly mitigate riparian habitat losses, we believe that all its associated costs should be considered nonreimbursable Federal costs or otherwise exempted from the cost-sharing requirements of the Federal Water Project Recreation Act. Implementation of the feature would produce average annual benefits consisting of 6,275 waterfowl hunter days valued at $8.00 each, 720 upland game hunter days valued at $5.00 each, 9,800 non-consumptive use days valued at $4.00 each, and 4,000 warmwater angler days valued at $3.00 each.

RECOMMENDATIONS

The following recommendations supplement, and in certain instances amend, the recommendations in our planning aid letter of May 13, 1976.

1. To mitigate fish and wildlife losses, we recommend that the project provide for:

   a. Use of 11,865 acres of project land, irrigation of 1,000 acres at Spenceville Wildlife Management Area, and acquisition and development of about 8,000 acres of privately owned land south of proposed Parks Bar Reservoir. Acquisition costs (not yet determined), as well as costs for development, estimated at $1,040,000, and annual OM&R, estimated at $230,000, should be designated project costs.

   b. Parking, sanitation and boat launching facilities at Parks Bar Reservoir to accommodate an average annual use of 29,700 angler days. All costs for these facilities, estimated at $49,000 for initial development and $72,000 for ultimate development with respective OM&R costs of $7,400 and $9,100, should be designated project costs.

2. To enhance fishery resources, we recommend that the project provide for:

   a. Enlargement of the hatchery previously recommended for mitigation so that existing anadromous fish runs could be increased by 50,000 chinook salmon and 10,000 steelhead trout, on an average annual basis. Costs for such enlargement (including visitor facilities) are currently estimated at $22,681,000 for capital expenditure and

$1,163,000 for annual operation, maintenance and replacement. All costs should be designated nonreimbursible Federal costs in view of the migratory nature of the resource benefited.

b. Angler access to the lower Yuba River at four or more locations including the afterbay dam, Daguerre Point Dam, Walnut Avenue, and the mouth of the river. Costs, not yet determined, should be designated nonreimbursable Federal costs.

c. Development of an improved fishery at Parks Bar Reservoir through expansion of the anadromous fish hatchery, initial stocking of coldwater and warmwater species, and construction of additional angler use facilities. All costs associated with this feature would be subject to the cost-sharing requirements of the Federal Water Project Recreation Act (P.L. 89-72).

3. To jointly mitigate fish and wildlife losses and enhance fish and wildlife resources, we recommend that the project provide for:

a. Acquisition and development (primarily for waterfowl) of about 1,200 acres of land southwest of the project boundary. Costs for development, currently estimated at $228,000; for OM&R, estimated at $34,000; and for acquisition, not yet determined, should be exempted from the cost-sharing requirements of the Federal Water Project Recreation Act because of the Federal interest in migratory bird management and because this feature would concomitantly mitigate wildlife losses.

Please advise us of your proposed actions concerning the foregoing recommendations.

Sincerely,

James W. Carson

for Felix E. Smith
Field Supervisor

Attachments: Tables 1, 2, &3

cc: ARD-Env. (ES), FWS, Portland, OR
NMFS, Tiburon, CA
Dir., CDF&G, Sacramento, CA
Reg. Mgr., CDF&G, Reg. II, Sacramento, CA

TABLE 1. Comparison Of Deer Numbers On Project Affected Lands Under Three Conditions
(number of deer each affected area is capable of supporting over 1 year)

Areas Affected by Project	WITHOUT PROJECT			WITH PROJECT WITHOUT MITIGATION			WITH PROJECT WITH MITIGATION		
	Initial	Year 50	Year 100	Initial	Year 50	Year 100	Initial	Year 50	Year 100
A. Lands within takeline									
Lands below gross pool and lands encumbered by project structures (7,200 acres)	594	505	416	0	0	0	0	0	0
Lands planned for general recreational use (2,040 acres)	211	178	148	165	106	0	165	117	0
Other lands affected by project (11,865 acres)	1,010	858	707	1,010	858	707	1,010	1,111	1,111
B. Lands outside takeline									
Lands recommended for acquisition and development (8,000 acres)	728	495	372	728	495	372	728	910	910
Spenceville W.M.A. (11,000 acres)	220	220	220	220	220	220	220	275	275
Other lands adjacent to and affected by project (2,000 acres)	119	101	83	119	71	24	119	71	24
TOTALS	2,882	2,357	1,946	2,242	1,750	1,523	2,242	2,484	2,320
AVERAGE ANNUAL VALUES		2,384			1,818			2,382	

TABLE 2. Comparison of Hunter Days On Project Affected Lands Under Three Conditions 1/

Areas Affected by Project	WITHOUT PROJECT Initial	WITHOUT PROJECT Year 50	WITHOUT PROJECT Year 100	WITH PROJECT WITHOUT MITIGATION Initial	WITH PROJECT WITHOUT MITIGATION Year 50	WITH PROJECT WITHOUT MITIGATION Year 100	WITH PROJECT WITH MITIGATION Initial	WITH PROJECT WITH MITIGATION Year 50	WITH PROJECT WITH MITIGATION Year 100
A. Lands within takeline									
Lands below gross pool and lands encumbered by project structures (7,200 acres)	2,160 2/ 2,160 3/	1,836 1,836	1,512 1,512	0 0	0 0	0 0	0 0	0 0	0 0
Lands planned for general recreational use (2,040 acres)	612 612	520 520	428 429	808 808	336 337	0 0	808 808	336 337	0 0
Other lands affected by project (11,865 acres)	3,559 3,560	3,025 3,026	2,491 2,492	7,119 7,119	7,831 7,831	7,831 7,831	7,119 7,119	7,831 7,831	7,831 7,831
B. Lands outside takeline									
Lands recommended for acquisition and development (8,000 acres)	2,400 2,400	1,635 1,635	1,230 1,230	2,400 2,400	1,635 1,635	1,230 1,230	5,160 5,160	9,575 9,575	9,575 9,575
Spenceville W.M.A. (11,000 acres)	3,150 3,150	3,150 3,150	3,150 3,150	3,150 3,150	3,150 3,150	3,150 3,150	3,150 3,150	6,728 6,728	6,728 6,728
Other lands adjacent to and affected by project (2,000 acres)	600 600	510 510	420 420	600 600	216 216	72 72	600 600	216 216	72 72
TOTALS	24,963	21,353	18,464	28,154	26,337	24,566	38,674	56,073	55,112

1/ Estimates of hunter days are divided equally between deer and upland game based on experience at Spenceville W.M.A.

2/ Deer hunter days, valued at $9.00 each

3/ Upland game hunter days, valued at $5.00 each

TABLE 3. Comparison of Angler Days for Yuba River and Tributaries under Four Conditions 1/

FISHERY	WITHOUT PROJECT			WITH PROJECT WITHOUT MITIGATION			WITH PROJECT WITH MITIGATION			WITH PROJECT WITH ENHANCEMENT		
	Initial	Year 50	Year 100	Initial	Year 50	Year 100	Initial	Year 50	Year 100	Initial	Year 50	Year 100
Resident Fish												
River:												
trout	4,400	6,600	8,800	1,000	1,500	2,000	4,400	6,600	8,800	6,100	9,150	12,200
non-trout	33,200	33,200	33,200	19,500	19,500	19,500	19,500	19,500	19,500	19,500	19,500	19,500
Reservoir:												
Englebright	9,500	12,700	19,000									
Parks Bar				9,500	12,700	19,000	23,200	26,400	32,700	44,200	58,000	85,000
Anadromous Fish												
Salmon												
ocean	33,600	33,600	33,600	28,560	28,560	28,560	33,600	33,600	33,600	75,600	75,600	75,600
river	14,400	14,400	14,400	12,240	12,240	12,240	14,400	14,400	14,400	32,400	149,400	149,400
Steelhead	3,200	3,200	3,200	320	320	320	3,200	3,200	3,200	19,200	23,200	23,200
American Shad	7,000	10,500	14,000	7,000	10,500	14,000	7,000	10,500	14,000	14,000	21,000	28,000
Striped Bass	2,000	3,000	4,000	2,000	3,000	4,000	2,000	3,000	4,000	4,000	6,000	8,000

1/ Angler day unit values:

salmon and steelhead	$9.00
resident trout and striped bass	$6.00
all other fish	$3.00

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF FISH AND GAME
1416 [illegible] STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-3531

December 14, 1976

Mr. Felix E. Smith, Field Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way, Room E-2727
Sacramento, California 95825

Dear Felix:

The Department of Fish and Game concurs in the conclusions expressed in your November 30, 1976 draft of the planning-aid letter to the U.S. Army Corps of Engineers regarding the Parks Bar site of the Marysville Project, Yuba River. We were especially pleased that you included a recommendation for a wildlife enhancement area. The Corps' acceptance of the wildlife enhancement plan would certainly demonstrate that river basin development has, indeed, been broadened to include long-desired benefits.

Concurrence of this Department should not, however, be construed as approval or endorsement of the Marysville Project. As you know, we are still conducting investigations and evaluations of project construction and operation plans.

Please send us five copies of your final letter.

Sincerely,

Chas

Director

DEC 16 1976

United States Department of the Interior
BUREAU OF RECLAMATION
MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY REFER TO: MP-740
125.1

JAN 27 1977

Colonel Donald M. O'Shei
District Engineer
Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

Dear Colonel O'Shei:

As requested in your letters of October 22, 1975 and November 4, 1976, a current evaluation of irrigation benefits for Marysville Lake Project has been prepared. An informal reply was provided to your staff November 19, 1976. That data and the data transmitted herewith must be considered preliminary and subject to revision since our internal review has not been completed.

The attached analysis is based on a 1974 cost level for farm budget inputs. We are presently in the process of updating our farm budget data bank to the 1975 level. Since debugging of the data bank is necessary, we anticipate it will be several months before analyses can be made based on the 1975 data.

The direct irrigation benefits at the reservoir computed at 3-1/4 percent and 6-3/8 percent, as requested, are $67 and $72 per acre-foot (rounded), respectively, as shown on page 8 of the enclosed appendix.

Sincerely yours,

H. E. Horton

H. E. Horton
Assistant Regional Director

Enclosure

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

FEDERAL POWER COMMISSION
REGIONAL OFFICE
U. S. CUSTOM HOUSE
SAN FRANCISCO, CA. 94111

February 1, 1977

Colonel Donald M. O'Shei
District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel O'Shei:

Please refer to your letter of December 30, 1976 (Your reference SPKED-W). We have reevaluated our previous load study of the Marysville Lake Project as you requested, using the revised project operations data that were enclosed with your letter. Also, additional studies were made to incorporate two data revisions received from your Mr. James Smith dated January 14, 1977, and a final revision dated January 24, 1977 which we received on January 26.

Estimated loads used in the studies are, as before, from those developed for the Western Systems Coordinating Council (WSCC) and reported in its "Reply to Federal Power Commission Docket R-362, Order 383-3," dated April 1, 1976. The study area, "Pacific Southwest Power Area, Sub-area D," approximates the Federal Power Commission's Power Supply Area 46.

Resources used in the studies were revised to include all generating units placed in service in 1976, and units under construction and planned as reported to the Federal Power Commission. Additional information was obtained from individual utilities. Generation requirements needed to supply the energy load, beyond the planned resources, are assumed to be supplied by nuclear-fired base load plants. As mentioned to Corps personnel at various times, these estimates of loads and schedules of planned resources are under review by utilities and revised material is scheduled to be submitted to the Commission on April 1, 1977.

August is the month of annual peak demand and was determined to be the critical supply month under adverse hydro conditions. An allowance of 20 percent was added to the estimated peak demand and your estimates of pumping energy needs were added to the energy loads in order to represent the total requirements to be met by the available supply in the critical month.

Our studies of estimated loads and resources show a need for additional system peaking capability in 1993. They show that the proposed Marysville Lake Project's initial installation plus the second increment of 450 MW for a total of 1800 MW peaking capability can dependably supply a portion of these additional requirements. Further study shows that the total Marysville proposed plant capability of 2250 MW could dependably supply a portion of the study area's peaking requirements in 1994.

In 1993, for the critical month of August, our study shows that pumping energy will be available only from fossil-fueled steam plants. After 1993, the most probable source of pumping energy is nuclear-fired generating plants. On this assumption and based on January 1, 1976 cost levels, pumping energy costs for 1993 are estimated to be 21.78 mills/kWh. After 1993,assuming availability of nuclear energy,pumping energy cost is estimated to be 3.24 mills/kWh based on the same January 1, 1976 cost levels.

Very truly yours,

George R. Bell

George R. Bell
Regional Engineer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1500 N.E. IRVING STREET
P.O. BOX 3737
PORTLAND, OREGON 97208

District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California

FEB 18 1977

Re: PL 89-72
Marysville Lake
Yuba County

Dear Sir:

Your office has informed us that a statement is needed from the Service establishing its position with respect to application of the cost sharing requirements of PL 89-72 to certain features of the Marysville Lake Project, Yuba County, California. The features in question were included in our Sacramento Field Office's planning aid letter to you dated December 21, 1976. They call for: (1) construction and Federal administration of a proposed hatchery and related facilities, (2) establishment of a 1200 acre waterfowl area, and (3) creation of angler access points.

The Service supports Federal administration of this hatchery since it constitutes an integral part of the Federal Program for the conservation and development of anadromous fish. In light of the Service's willingness to administer this facility, the enhancement costs of this feature should be exempted from the cost sharing requirements of PL 89-72. The Service believes that Section 1 of this act supports this position.

Opposition to the establishment of the proposed waterfowl area has been voiced by Beale Air Force leadership. The basis for their concern is the potential hazard to aircraft from bird strikes that could result from creation of a managed waterfowl area on and adjacent to the air base. In light of this factor, the Service proposes to delete this feature from project plans. As a result, our position with regard to the cost sharing aspects of PL 89-72 for this feature is no longer a consideration.

Unlike the hatchery proposal, the development of access does not aid in the conservation and development of anadromous fish. As a result, this feature will require cost sharing as outlined in PL 89-72.

It is hoped this information will be of use to you in implementing your project.

Sincerely yours,

R. Kahler Martinson

R. Kahler Martinson

cc: ES, Sacramento

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX C - SYNOPSES OF PRIOR REPORTS

APPENDIX C - SYNOPSES OF PRIOR REPORTS

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APPENDIX C - SYNOPSES OF PRIOR REPORTS

1. Bulletin No. 26, Sacramento River Basin, California Division of Water Resources, 1931. - Bulletin No. 26 discussed a major reservoir on the upper Yuba River as a required element of the State Water Plan for irrigation of lands in the Yuba River water service area. The report noted that since Yuba River runoff exceeds supplies needed for local irrigation and since studies indicated all water supply in the Sacramento basin which could be economically developed would ultimately be required for development of the Central Valley, a major reservoir on the Yuba River would make water available for areas outside the local service area. The report discussed two potential damsites on the Yuba River, one at the Narrows, about one mile downstream of Deer Creek, and one about 1.75 miles upstream.

2. Sacramento River and Tributaries, California, from Collinsville to Shasta Dam, House Document No. 649, 78th Congress, 2d Session 5 June 1944. - This document reported on a preliminary examination and survey of the Sacramento River and tributaries for flood control, power, conservation of water, and other purposes, and recommended a general plan of development for the resources of the valley. The recommended work included a 920,000 acre-foot reservoir at the Narrows site on the Yuba River.

3. Engineering Geology of Yuba and Bear Rivers Drainage Basins to Accompany Interim Report on Initial Project, California Department of Water Resources, 1959. - The California Department of Water Resources investigated

the Marysville, Parks Bar and Dry Creek damsites in 1958, during a study of the Yuba and Bear rivers. Some exploration work was done at each site. Most of the detailed data from that study is no longer available, and no detailed base maps were available at that time for location of explorations. Results of exploratory drilling by the dredging companies in the Yuba dredge field were summarized to delineate buried bedrock channels beneath the deep alluvial fill. These investigations were reported in "Engineering Geology of Yuba and Bear Rivers Drainage Basins to accompany Interim Report on Initial Project."

4. Report on Development of Water Resources of Yuba River, and Addendum No. 1, International Engineering Company, January and June 1961, respectively. - This report was prepared for the Yuba County Water Agency and presented a recommended plan of development for the Yuba River which included construction of New Bullards Bar Reservoir, New Colgate powerhouse, and New Narrows powerhouse as major features. Appendixes to the report presented detailed information on full natural and impaired streamflow at various points in the Yuba River basin and on reservoir operation studies.

5. Progress Report on Yuba and Bear River Drainage Basin Investigation, California Department of Water Resources, May 1961. - This report called for a dual reservoir project consisting of an 860,000 acre-foot New Bullards Bar Reservoir and a downstream reservoir at either the Parks Bar or Marysville site at capacities of 825,000 acre-feet and 1,000,000 acre-feet, respectively.

6. <u>Definitive Reservoir Operation and Power Study, International Engineering Company, March 1963</u>. - This study evaluated the effects of revisions in channel releases for fish, change in location of some releases for Browns Valley Irrigation District, curtailment in fish releases during dry years, and a minor reduction in irrigation accomplishments. It also differentiated between the operation of existing and new powerplants. This report updated the "Report on Development of Water Resources of Yuba River" prepared in 1961 (see paragraph 5), in light of new agreements executed by YCWA and the California Department of Fish and Game, an agreement by Nevada Irrigation District to release a minimum flow from Milton Dam, and refinements in power and irrigation releases.

7. <u>Bulletin No. 115, Yuba and Bear Rivers Basin Investigation, California Department of Water Resources, April 1964</u>. - The purpose of this study was to formulate a comprehensive plan for basinwide development to meet projected water requirements to the year 2020. The initial concern of the study was the selection of a major multiple-purpose project on the lower Yuba River to fulfill the requirements of water resources development, including flood control and possible export of water to the Delta under the State Water Plan. The study recommended construction of Marysville Lake project 1.5 miles upstream from Daguerre Point Dam as the second (after New Bullards Bar) and final stage of the proposed lower Yuba River project.

8. <u>Bullards Bar, Yuba River Basin, California, House Document No. 180, 89th Congress, 1st Session, 24 May 1965</u>. - Detailed survey studies on the Yuba River basin were reported on in the "Review Report, Yuba River Basin, California," dated 31 October 1963, which was published in this House Document. Studies reported on included studies of the Marysville Lake project as well as studies of New Bullards Bar Reservoir. Federal participation in the undertaking of the New Bullards Bar project was authorized in the Flood Control Act of 1965 in accordance with recommendations in this report.

The District and Division Engineers found that the Marysville-Yuba City area and surrounding Yuba and Feather River flood plains could not be protected adequately by provision of flood control storage in New Bullards Bar Reservoir alone. They concluded that additional flood control storage should be provided at the Marysville site, and that the Marysville project should be the next major unit to be developed on Yuba River after the New Bullards Bar project. The Board of Engineers for Rivers and Harbors found the plan presented by the District and Division Engineers for development of the Marysville site to be engineeringly feasible and economically justified and recommended that the Corps of Engineers be authorized to construct and operate a multiple-purpose dam, reservoir, powerplant, and appurtenant facilities at that site for flood control, municipal and industrial water supply, recreation, power, and other purposes, as described in the District Engineer's report.

9. <u>Marysville Dam and Reservoir, Yuba River Basin, California, House Document No. 501, 89th Congress, 2d Session, 29 September 1966</u>. - The report of the Chief of Engineers recommending that the Corps of Engineers be authorized to construct and operate the Marysville Lake project, together with comments of other agencies, was published in this House Document. This report also provided for non-Federal participation in development for fish and wildlife, financial integration of the project with the Central Valley Project (CVP), construction of electric transmission facilities by the Bureau of Reclamation to interconnect the project with the CVP, detailed definition of project lands required as a part of postauthorization studies, advance acquisition of title to such lands to preserve the site against incompatible development, and participation by the Corps of Engineers in the construction or reconstruction of transportation and utility facilities in advance of project construction to preserve such areas from encroachment and avoid increased costs. Acting on advice from the State of California and the Bureau of Reclamation, the report listed irrigation as the major water conservation purpose rather than M&I water supply. The Marysville Lake project was authorized by Congress in the Flood Control Act of 1966, in accordance with the recommendations in House Document No. 501.

10. <u>South Yuba Water Development, A Preliminary Report, Yuba County Water Agency, January 1968</u>. - The Yuba County Water Agency, in cooperation with the South Yuba Irrigation Planning Committee, conducted a study of development of an alternative source of irrigation water supply for the area south of the Yuba River, to supplement and replace inadequate ground water supplies.

The study is summarized in "South Yuba Water Development, A Preliminary Report." The report concluded that ultimate water requirements in the service area can be satisfied only with reregulation of Yuba River streamflow, which would be provided by the Marysville Lake project. The report recommended an interim diversion development to irrigate 47,000 acres of which about 41,000 acres are presently supplied mainly by wells; however, no further action has been taken to implement the South Yuba Water Development plan.

11. Flood Plain Information Report, Feather and Yuba Rivers, Marysville-Yuba City, California, Sacramento District, Corps of Engineers, June 1968. - At the request of the California State Reclamation Board and Butte, Sutter and Yuba Counties, the Corps of Engineers conducted this flood plain information study of the flood hazard, due to the Feather and Yuba Rivers, in the vicinity of the cities of Marysville and Yuba City.

12. Design Memorandum No. 1, Water Quality Control, Sacramento District, Corps of Engineers, February 1969. - Subsequent to project authorization, the Corps of Engineers conducted studies to reappraise water quality control measures at Marysville Lake as a possible project purpose. Information developed in these studies is contained in Design Memorandum No. 1, "Water Quality Control." It was concluded that water quality of the Yuba River is high and well suited to existing and anticipated future beneficial uses, that the State is actively pursuing a course to preserve the existing high quality of Yuba River water, and that storage of water in Marysville Lake for water quality control purposes is not needed.

13. <u>Post-Construction Reservoir Operation and Power Study, International Engineering Company, November 1969</u>. - International Engineering Company prepared a revised and updated report for the Yuba County Water Agency to supersede earlier reservoir operation and power studies. This report incorporated revised designs, parameters, and criteria for the project as constructed and requirements for minimum energy generation for the New Colgate plant as stipulated in the power purchase contract between the Yuba County Water Agency and Pacific Gas & Electric Company, dated May 1966. Irrigation requirements were reduced in this study.

14. <u>Design Memorandum No. 2, Hydrology, Sacramento District, Corps of Engineers, revised April 1971</u>. - Subsequent to project authorization, the Corps of Engineers conducted detailed hydrologic studies of the Yuba River basin. Information developed in these studies is contained in Design Memorandum No. 2, "Hydrology," revised April 1971, and approved by OCE on 27 June 1972. That memorandum contains basic hydrologic data, describes development of the standard project flood, the spillway design flood, freeboard criteria, wave action, and other hydrologic information for a 968,000 acre-foot project at the Browns Valley site. Information on hydrology in this Phase I General Design Memorandum supplements and supersedes information in Design Memorandum No. 2.

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX D - RECREATION RESOURCES

APPENDIX D - RECREATION RESOURCES

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APPENDIX D - RECREATION RESOURCES

SECTION I - INTRODUCTION

1. Purpose and scope. -

This appendix discusses the recreation and fish and wildlife resources potential of the Marysville Lake project located at the Parks Bar site (Figure D-1). It identifies existing recreation and fish and wildlife use in the project area; proposes a recreation and fish enhancement plan; discusses alternative recreation development plans; and presents estimates of use, benefits, and costs for the recommended and alternative recreation development plans. It also describes environmental losses associated with the overall project and protective and mitigative measures, including lands and facilities for mitigation of project-related fish and wildlife damages.

2. Authorization. -

The Marysville Lake project was authorized for construction by Title II of the Rivers and Harbors - Flood Control Act of 7 November 1966 (Public Law 89-789, 89th Congress, 2nd Session). The authorization was modified by Section 159 of the Water Resources Development Act of 1976, 94th Congress, 2d Session.

3. Background. -

a. Requirements of local cooperation. - The requirements for local cooperation for recreation and fish and wildlife, in accordance with the Federal Water Project Recreation Act, are set forth in House Document No. 501, 89th Congress, 2d Session, in paragraph 10a(3) of the Report of the Chief of Engineers to the Secretary of the Army, and are as follows:

"(1) Administer project land and water areas for recreation and fish and wildlife enhancement;

(2) Pay, contribute in kind, or repay (which may be through user fees) with interest one-half of the separable cost of the project allocated to recreation and fish and wildlife enhancement, the non-Federal cost involved currently being estimated at $950,000; and

(3) Bear all costs of operation, maintenance, and replacement of recreation and fish and wildlife lands and facilities, the non-Federal cost currently being estimated at $94,000 on an average annual basis."

b. Federal Water Project Recreation Act. - Public Law 89-72, the Federal Water Project Recreation Act, was enacted on 9 July 1965 just prior to the Corps of Engineers submitting to Congress the survey report upon which authorization was based. The law specifies two separate types of financing for recreation and fish and wildlife enhancement as a part of water resources

projects. In Section 1, the law specifies that project construction agencies should encourage non-Federal public bodies to participate with the Federal construction agency in the costs and administration of outdoor recreation and fish and wildlife enhancement areas and facilities ".... unless such areas or facilities are included or proposed for inclusion within a national recreation area, or are appropriate for administration by a Federal agency as a part of the national forest system, as a part of the public lands classified for retention in Federal ownership, or in connection with an authorized Federal program for the conservation and development of fish and wildlife."

c. Non-Federal agency administration. - The California Resources Agency, by letter dated 29 June 1966 to Sacramento District, indicated their intent " . . . to provide the necessary leadership in furnishing, for the Marysville Lake Project, the assurances of local cooperation required by the Federal Water Project Recreation Act." In a letter dated 4 May 1971 the Resources Agency reversed that position, stating that they did not feel that " . . . participation in any proposed recreation facilities at Marysville Reservoir can be deemed necessary and desirable by the state." The Department of Parks and Recreation confirmed this latter position in a letter dated 3 June 1976.

For plans based on non-Federal participation, the extent of non-Federal cost-sharing participation in both initial and future phases of recreation development determines the amount and the quality of facilities that can be

developed. Without non-Federal participation, the Federal Water Project Recreation Act, Public Law 89-72, prohibits inclusion of recreation and fish and wildlife enhancement as project purposes. Thus, without non-Federal participation, recreation development would be limited to minimum facilities for public health and safety. This minimum development would not constitute a recreation purpose. However, recreation and fish and wildlife enhancement may be included as part of another authorized Federal program without non-Federal cost sharing or administration, as described in paragraph 3b.

In the absence of non-Federal cost-sharing for recreation, Public Law 89-72 permits the Corps of Engineers to acquire all the lands needed to develop the full recreation potential of the project. The Corps may retain these lands for 10 years after the project becomes operational and may enter into cost-sharing agreements with non-Federal interest to provide recreation development during that period. If agreements for recreation development are not executed during this 10-year period, the Corps may use these lands for other lawful purposes or may dispose of them.

d. Federal agency administration. - For plans based on other Federal agency administration, the number and quality of facilities to be developed are determined through advice received from the other Federal agencies concerning authorized Federal programs which they administer and the appropriate contribution from the water resources project which they would administer.

Through recent coordination with the Fish and Wildlife Service, National Marine Fisheries Service, and the California Department of Fish and Game, fish

enhancement features have been identified and included in the project that the Fish and Wildlife Service would administer in connection with other authorized Federal programs.

e. Fish and wildlife. - The specific enhancement features discussed above were developed through recent coordination. At the time the project was authorized, the Chief of Engineers wrote the State of California (letter dated 12 July 1965, published in House Document No. 501) as follows.

> Your recommendations relative to recreation and fish and wildlife enhancement and mitigation are noted in particular. You may be assured that these matters will receive full and careful consideration during the preconstruction planning stage, if the project is authorized by Congress. I am confident that a mutually acceptable plan of development for these project purposes can be worked out at that time.

Additional information on mitigation and enhancement programs is presented in Section VII.

4. Alternative recreation development. -

The alternatives are summarized in this paragraph and discussed in more detail in Section III.

a. <u>Optimum development with non-Federal participation</u>. - Full development of the project for recreation and fish and wildlife enhancement purposes could be accomplished in a joint Federal - non-Federal program to provide the facilities necessary to develop the full public use potential of the project, including the Yuba River below the afterbay. Facilities would be developed for such activities as camping, picnicking, boating, swimming, fishing, and hiking. This plan cannot be implemented since there is no non-Federal public agency willing to participate in costs of development or administration of completed facilities, as required by Public Law 89-72 and the project authorization.

b. <u>Recommended development</u>. - The recommended development plan consists of a scaled-down version of the optimum development plan for the Yuba River downstream from the afterbay and a minimum development for public health and safety at the lake. The Yuba River development will consist primarily of general recreation facilities, with substantial facilities for fishermen access, and will be developed jointly with and operated and maintained by Yuba County. The lake facilities will be administered by the Corps of Engineers.

c. <u>Single-purpose recreation alternative</u>. - Two single-purpose alternatives, which would provide essentially the same amount of use as the selected plan, were investigated. One plan consists of a river corridor with river access sites from Englebright Dam to the mouth of the Yuba River. The second plan consists of a lake at the Browns Valley site and a river corridor with access sites downstream to the mouth of the Yuba River.

SECTION II - DESCRIPTION OF PROJECT AREA

5. Project location. -

The project area lies at the western edge of the Sierra Nevada foothills about 15 miles northeast of Marysville, California, on the Yuba River (Figure D-1). The main damsite is about 6 miles upstream from the existing Daguerre Point Debris Dam and about 16 miles and 4 miles downstream from New Bullards Bar Dam and Englebright Dam, respectively.

6. Climate. -

Climate of the project area is typical of the east side of the Sacramento Valley. Summers are dry with temperatures reaching 100°F (38°C), and winters are wet with freezing temperatures not unusual. Precipitation occurs mostly as rainfall between October and March (85 percent of total). Between the 100 and 1,500-foot elevations, the average annual precipitation ranges from 25 to 40 inches. Winds are generally light, rarely exceeding 15-20 miles per hour during the summer.

7. Topography, geology, seismicity, and soils. -

The project area is part of the Yuba River watershed, an area encompassing about 1,350 square miles and primarily drained by the North, Middle, and

South Yuba Rivers. Steep-sided cliffs with heights up to 2,500 feet dominate the topography at the eastern end of the project. The western topography is open and gently rolling. Lee Hill and Howard Hill are the predominant features. From the eastern to the western ends of the project area the riverbed drops from 550 feet msl to 200 feet msl.

Man-made features characterize the project lands downstream of the afterbay. Dredge tailings occupy much of the area along the lower Yuba River. They lie in symmetrical piles as high as 100 feet often separated from each other by networks of channels and ponds with no surface inlets or outlets. Hydraulic mining during the last 25 years has helped shape the landscape near Smartville and Timbuctoo. There, several steep, bare cliffs remind the residents and visitors of the earlier days of hydraulic mining methods which washed away great amounts of material to recover gold.

The Yuba River flows through a narrow rock-walled canyon in the eastern project area to just downstream of the damsite where the river enters the wider flood plain in the Sacramento Valley. Dry Creek flows through a less rugged canyon which is generally scoured to bedrock and joins the Yuba River in the widened flood plain downstream of the afterbay.

8. Land use. -

Much of the land use in the project area is agricultural. Nonirrigated field crops such as wheat, alfalfa, oats, and barley are grown principally

on the valley floor. The foothills support rangeland, with cattle grazing the principal agricultural activity. The University of California maintains the 5,870-acre Sierra Foothill Range Field Station in the area west of Englebright Lake and north of Timbuctoo Bend. About 13 percent (740 acres) of the lands owned by the Field Station would be inundated by the Marysville Lake project at gross pool, and an additional 7 percent (400 acres) would be acquired for project purposes.

Limited nonagricultural land uses occur in and around the project area. Yuba Goldfields, Inc., has been mining for gold at the dredge tailings downstream from the project in the vicinity of Hammonton. Several sand and gravel operations are located along the Yuba River between Englebright Dam and Marysville. The Marysville-Yuba City urban complex lies at the confluence of the Yuba and Feather Rivers, and there is limited residential development in the nearby communities of Browns Valley and Smartville. Beale Air Force Base (AFB) maintains a 23,500-acre military base southwest of the project area.

Large acreages of public lands occur south and east of the project area. Spenceville Wildlife Management and Recreation Area, which encompasses 11,213 acres south of the project area, is administered by the California Department of Fish and Game. The Malakoff Diggins State Historic Park encompasses 2,600 acres in the Sierras, about 50 miles east of the project area, and is administered by the California Department of Parks and Recreation. Three National Forests - Plumas, Tahoe, and Eldorado - cover extensive acreage in the Sierra 25 to 50 miles east of the project area.

9. Accessibility. -

State Highway 20 provides the principal access to the project area from Marysville and Yuba City, which are located about 15 and 17 miles southwest of the lake, respectively. An extensive system of freeways and other highways connects metropolitan Sacramento (40 miles south of Marysville), the San Francisco Bay area to the southwest, and other population centers with the city of Marysville. Travellers from Grass Valley and other points east can reach the project area via State Highway 20; persons from foothill cities to the north of the project area can gain access via County Road No. 8, Marysville Road. The California Department of Transportation has been studying improving access along State Highway 20, and along State Highway 70 from Sacramento to Marysville.

10. Recreation resources. -

Limited public access currently restricts recreation activities along the Yuba River and its tributaries. Some informal access can be gained from State Highway 70 and the county roads, and both Yuba Goldfields, Inc. (at Hammonton), and the U.C. Sierra Foothill Range Field Station allows limited use of its lands. Recreational uses, including hunting, fishing, boating, canoeing, kayaking, rafting, swimming, gold panning, and nature study, occur where access to the river and its tributaries can be gained. The more easily accessible foothill woodlands dominating the project area also support hunting, bicycling, horseback riding, and various nature study activities. Fishing

is the most popular of the recreational uses in the area. People fish the Yuba River and its tributaries throughout the year for salmon, American shad, trout, steelhead, catfish, smallmouth bass, and green sunfish.

11. Cultural resources. -

Cultural resources of the project area derive primarily from the Maidu Indian tribes which formerly inhabited the area and from the gold mining era. Both reconnaissance and detailed surveys of cultural resources of the project area were conducted for the Corps of Engineers.(3) These surveys located and recorded 430 sites, as follows:

	Prehistoric	Historic	Total
Within gross pool	113	132	245
Above gross pool in project area	124	61	185
Total	237	193	430

12. Water resources. -

Hydrology of the Yuba River in the vicinity of the project area is characteristic of general conditions found along the west side of the Sierra Nevada mountain range. Below 4,000 feet elevation precipitation falls as rain while generally above this elevation winter precipitation falls as snow. Highest streamflows generally occur from February to May due to water holding capacity of the watershed and spring snowmelt at higher elevations. New

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

Bullards Bar Lake and Englebright Lake are reservoirs on the North and mainstem Yuba River, with total storage capacities at 960,000 and 70,000 acre-feet, respectively. Eight other reservoirs are located in the river basin and are utilized for power production, irrigation, water supply, recreation, and related purposes. The following tabulation shows the average flow in cubic feet per second (cfs) of the Yuba River below the Marysville Lake project, including pre- and post-New Bullards Bar flows. In addition, post-Marysville Lake flows are projected.

Average Annual Discharges 1/
(cfs)

Month	Pre-Bullards Bar: Oct 49 - Nov 70	Post-Bullards Bar: Dec 70 - Nov 74 2/	Post-Marysville Lake 3/ (Partial Impairments 70% YCWA Usage) 4/
January	4,945	5,165	3,135
February	5,541	3,801	3,952
March	4,086	4,117	3,500
April	4,904	3,462	2,163
May	5,182	1,671	2,898
June	2,661	2,191	2,055
July	527	1,583	1,474
August	258	1,942	878
September	316	1,587	1,492
October	599	1,578	1,512
November	972	2,592	1,699
December	3,490	3,798	2,147

1/ Discharge readings from Oct. 1949 to Sept. 1957 obtained from 2 miles upstream from the mouth of the Yuba River. Readings from Oct. 1957 to present obtained 5 miles downstream from confluence of Dry Creek and the Yuba River. (4) (11) (12)

2/ Since this is not necessarily a representative period, these figures are not strictly comparable.

3/ 14 May 1976 U.S. Bureau of Reclamation Study, Gross Pool Elevation 560, Minimum Pool 273,000 acre-feet.

4/ See Reference (1) for discussion of these conditions.

The quality of water in a stream such as the Yuba primarily depends on the relative volume of flow in the stream and the quantity of pollutants discharged into the stream. Municipal wastes, industrial wastes (mining and lumber mills), erosion, and irrigation return flows constitute the major sources of potential pollution along the Yuba River. An earlier evaluation of mining and lumber operations showed that pollutants from these sources are controlled to such an extent that they do not present any potential for lowering the quality of the Yuba River water.(7) This conclusion was partially based on the assumption that there are few such remaining operations working in the area. Renewal of mining activity or substantial increases in logging activity could alter this situation. Water quality in the Yuba River is discussed in detail in Appendix G. Irrigation return flow enters the Yuba from Dry Creek, and constitutes a good portion of the water in the creek during the summer. Since irrigation return flows often contain high amounts of fertilizers, inorganic salts, and pesticides, the algal blooms often observed in Dry Creek in summer probably result from the nutrients in the return flow.

Water quality data for the Yuba River at Marysville, based on monthly sampling average for the 1966 through 1970 period, show Yuba River water to have low salinity and low boron concentrations, fairly low amounts of dissolved nutrients (nitrogen and phosphorus) that typically cause eutrophication, and high concentrations of dissolved oxygen. These characteristics all indicate good water quality. The water quality of the Yuba during low flow periods has improved since the completion of the New Bullards Bar Dam in 1970. The

flow throughout the year is more constant, and the water is clearer and colder, with a lower mineral content.(6)

The Corps of Engineers conducted a sampling and analysis program in the project area to determine current water quality; results are discussed in Appendix G. The program includes stream sampling in the Yuba River below Englebright Dam, near the mouth of Dry Creek, and near the mouth of Deer Creek, and monthly sampling at New Bullards Bar and Englebright Lakes. Results confirm that water quality is generally good except that chlorinated hydrocarbons were somewhat high in May and June 1976 sampling. Temperature profiles for Englebright Lake and New Bullards Bar Lake show the development of a thermocline as summer progresses, with the lakes overturning and becoming isothermal in winter.

Yuba River water temperatures are of particular concern due to the cold temperatures required by salmon and steelhead and the fact that other fish species with different temperature requirements are also present. In addition, agricultural water users desire water temperatures during the growing season suitable for agricultural production, particularly for rice. Historical water temperatures and simulation studies for conditions with the Marysville Lake project are discussed in Appendix G.

The Corps of Engineers contracted with BEAK Consultants, Inc., in December 1975 to conduct a study(2) to determine the levels of mercury, lead, and boron in water, sediments, plants, and animals in the project area and the

probability that inundation of gold mining dredge tailings by the project and excavation of the riverbed for construction might release undesirable amounts of these elements into the environment. The concentrations of mercury in water, sediments and biological materials were not greater than concentrations measured in comparable areas in California, and while some fish exceeded U.S. Food and Drug Administration (FDA) guidelines for human consumption, this cannot be considered unusual in light of measurements made elsewhere in California.(2) Lead was present in detectable amounts in some sediment samples, algae, and willow leaf samples. However, the concentrations of lead measured were low and comparable with values measured in other unurbanized areas in California. Boron levels in water were well below the national average and considerably less than the averages for the Sacramento River. Results of this study are discussed in detail in Appendix G.

Ground water supplies in the project area are of good quality, with few localized areas showing a relatively high mineral content. Ground water levels have declined in recent years, as discussed in Appendix J.

13. <u>Biological resources</u>. -

The vegetative setting of the project area is primarily the foothill woodland community type, with riparian vegetation along the watercourses, all modified by agricultural activities typical of the western Sierra foothills.(1) The foothills, while less productive than the more fertile agricultural lands of the valley, provide grazing for domestic animals and

habitat for many species of terrestrial and aquatic wildlife. Deer, quail, turkey, and salmon are notable fish and wildlife species inhabiting the project area.(1) They provide considerable outdoor recreation opportunities for hunters and anglers. Other fish, including anadromous steelhead, American shad and striped bass, provide additional fishing opportunities. The other numerous, though often inconspicuous, terrestrial wildlife species provide some additional hunting opportunities and nonconsumptive wildlife uses such as bird watching and nature study. Additional information on biological resources in the project area is contained in Section VII. A detailed listing of flora and fauna in the project area is provided in the report by BEAK Consultants, Inc.(1)

14. Lake data. -

	Elevation (feet)	Surface Area (acres)	Storage Capacity (acre-feet)
Inactive Pool	455	3850	367,000
Normal Recreation Pool (Avg.)	545	6240	820,000
Gross Pool	560	6640	916,000

15. Normal recreation pool. -

At normal recreation pool, which is the average pool in the April through August period the lake would be about 13 miles long, with 64 miles of shoreline and a maximum depth of 340 feet. The average end-of-month elevations and surface areas, based on the U.S. Bureau of Reclamation operation studies, would be as follows:

Month	Elevation (feet)	Surface Area (acres)
April	545	6,240
May	547	6,290
June	546	6,260
July	544	6,210
August	541	6,130

The storage frequency by months and stage duration for the recreation are shown in Figures D-2 and D-3, respectively. The data presented in these

figures were used in planning the location of recreation facilities and supporting utilities and in developing the optimum recreation plan. The interrelationship of seasonal pool elevations, seasonal visitation, and facility location affects the quality of the recreation development.

16. Afterbay. -

The afterbay impoundment would have a length of about 3 miles, extending from the afterbay dam location at Long Bar upstream to Parks Bar, and would have a surface area of approximately 1080 acres at gross pool. Power operation studies indicate that the afterbay would fluctuate daily, with a gradual increase in water level during the week to about gross pool storage (54,200 acre-feet for Stage I) and a decrease over the weekend to about inactive pool storage (9,300 acre-feet), a vertical fluctuation of about 55 feet. Because of the large daily pool fluctuation and the accompanying safety hazards, public recreation and fish and wildlife uses of the afterbay are not appropriate.

SECTION IV - RECREATION MARKET AREA AND ATTENDANCE - LAKE AREA

17. Recreation, market area and population. -

An area within a 50 road-mile radius of the project is defined as the project market area (Figure D-4). Eighty percent of the day use and 50 percent of the overnight use are expected to originate from this area. Much of the remaining day and overnight use is expected to come from as far away as the San Francisco Bay area, or a 150 road-mile radius from the project. Population within this 150 road-mile radius is expected to develop as follows:

Year	Population (in millions)
1975	5.1
1990	6.0
2020	8.7

Selected population concentrations in the area, their approximate road-mile distances from the project, and available population data are shown in the following tabulation.

	Miles	Population 1970	1975
Beale AFB	8	--	6,975 5/
Marysville	17	9,353 4/	--
Yuba City	19	13,986 4/	--
Oroville	37	7,536 4/	--
Chico	58	19,580 4/	--
Sacramento SMSA 1/	57	800,592 4/	879,100 6/
Stockton SMSA 2/	111	290,208 4/	302,000 6/
San Francisco SMSA 3/	150	3,109,519 4/	3,124,800 6/

1/ Sacramento Standard Metropolitan Statistical Area: Placer, Sacramento and Yolo Counties.
2/ Stockton SMSA: San Joaquin County.
3/ San Francisco SMSA: Alameda, Contra Costa, Marin, San Francisco, and San Mateo Counties.
4/ U.S. Department of Commerce, Bureau of the Census, 1971. Number of Inhabitants, 1970 Census of Population, California.
5/ Major Rowland, Information Officer, Beale AFB, November 1975.
6/ California Department of Finance, Population Research Unit, Advance Report, Report 75 E-2, October 1975.

18. Alternative recreation resources. -

Three National Forests (Eldorado, Plumas, and Tahoe) and five large lakes (Camp Far West, Englebright, Folsom, New Bullards Bar, and Oroville) are within an hour's travel time of the project site by automobile. Recent use and facility data for these areas are shown in the next tabulation.

Name of Facility	Campsites	Picnic Sites	Use	Year
Eldorado N.F.	1050 1/	225 1/	3,011,200 1/	1974
Plumas N.F.	1275 1/	135 1/	NA	NA
Tahoe N.F.	2300 1/	455 1/	4,341,200 1/	1974
Camp Far West Reservoir	50 2/	110 2/	102,000 2/	1974
Englebright Lake	--	50 4/	120,800 4/	1975
Lake Folsom	150 3/	NA	2,395,200 3/	Jul 74-Jun 75
Lake Oroville 6/	250 5/	125 2/	765,000 3/	" "
New Bullards Bar Reservoir	130 2/	60 2/	80,000 1/2/	1975

1/ U.S. Forest Service data.
2/ California Dept. of Water Resources, Davis-Grunsky Section, data.
3/ California Dept. of Parks and Recreation data.
4/ U.S. Army Corps of Engineers, data.
5/ Southern California Auto Club data.
6/ Includes Thermalito Afterbay.
NA Data not available.

In addition to the five lakes discussed above, two other large scale multiple-purpose dams are under construction within 150 miles of Marysville Lake: Auburn Dam, upstream of Folsom Lake on the American River; and New Melones Dam on the Stanislaus River.

The network of rivers in the Sacramento Valley and the Sacramento-San Joaquin Delta into which they flow are also major recreation resources in the project area. The three rivers that are the major components of this network are the Sacramento, Feather, and Yuba Rivers. These, with the Delta waterways, provide a variety of waterborne and shore-based recreation opportunities which include fishing, boating, waterskiing, swimming, picnicking, camping, bicycling, hiking, and horseback riding.(9)

A variety of other outdoor recreation opportunities exist within about an hour's driving time from the project. Most of the major attractions in this group are categorized and listed below.

California Department of Parks and Recreation Areas

Bidwell Mansion State Historic Park

Camillus Nelson State Historic Farm

Colusa-Sacramento River Recreation Area

Governor's Mansion

Malakoff Diggins State Historic Park

Old Sacramento State Historic Park

State Indian Museum

Sutter's Fort State Historic Park

Wildlife Areas

Sacramento National Wildlife Refuge

Colusa National Wildlife Refuge

Delevan National Wildlife Refuge

Sutter National Wildlife Refuge

Grey Lodge Wildfowl Management Area

Spenceville Wildlife Management Area

Lake Areas

Camp Far West Reservoir

Collins Lake

Folsom and Nimbus Lakes

Lake Francis

Lake of the Pines

Lake Oroville

Lake Wildwood

Rollins Reservoir

Royal Pines Lake

Sly Creek Lake

Upper & Lower Scotts Flat Reservoir

19. Recreation opportunities. -

The optimum land development for Marysville Lake would provide opportunities for camping, picnicking, boating, swimming, fishing, hiking, bicycling, and horseback riding. Support facilities such as camping areas, picnic areas, boat ramps, beaches, fish cleaning stations, and trails should enhance recreational opportunities. The recreation use received at similar Corps projects, local and nationwide, indicates that facilities at the Marysville Lake project would receive adequate use. The following paragraph presents estimates of use for this project and discusses the estimating methodology. It should be noted that there is no non-Federal sponsor for recreation at the lake; and only minimum facilities for health and safety will be provided. Accordingly, use estimates for the optimum and recommended plans for the lake vary widely.

20. Estimates of recreation use. -

As previously discussed, this appendix describes optimum and recommended recreation development plans. The recreation use expected at the lake for these two plans and for the fish- and wildlife-related activities is tabulated below. Estimated use for the Englebright portion of the lake (150,000 recreation days) is not included since this use would occur with or without the Marysville Lake project.

General Recreation and Fish and Wildlife Use
(in recreation days)

	Recreation Use		Fish and Wildlife Use	
Year	Optimum Plan 1/	Recommended	Hatchery	Hunting
1990	350,000	70,000	65,000	5,000
1993	390,000	150,000	100,000	5,000
2000	400,000	150,000	110,000	5,000
2010	450,000	150,000	120,000	5,000
2020	500,000	150,000	130,000	5,000
2030	550,000	150,000	140,000	5,000
2040	600,000	150,000	150,000	5,000
2050	650,000	150,000	160,000	10,000
2060	750,000	150,000	170,000	10,000
2070	800,000	150,000	180,000	10,000
2080	900,000	150,000	190,000	10,000
2090	1,000,000	150,000	200,000	10,000

1/ Includes reservoir fishing - 12 percent of total.

The expected recreation use for the optimum development plan was estimated by using methods discussed in "Plan Formulation and Evaluation Studies - Recreation," U.S. Army Corps of Engineers, 1974.(8) Basically, this methodology calls for: (a) selecting existing projects similar to the planned project;

(b) determining the recreation use characteristics of those projects; (c) identifying zones from which the similar projects' use originates (market area); (d) determining the per capita use rate for these zones (Figure D-5); (e) applying a similar market area and per capita use rate to the planned project; and (f) projecting the recreation use of the planned project using the applied per capita use rates and the accepted population estimates for the market area zones.

Since there is no non-Federal sponsor for recreation at the lake, the recommended plan includes only development of facilities for public health and safety, primarily at the ends of existing roads, and relocation of inundated facilities at Englebright Lake. It is estimated that annual recreation use would be 150,000 recreation days, or about 10,000 recreation days of use for each developed road-end. It is expected that a marina and related facilities will be operated by a concessionaire at the lake to provide the public with certain services.

Project recreational uses related specifically to fish and wildlife include hatchery visitation and hunting on project lands managed for wildlife. The 1993 estimate of 100,000 recreation days of hatchery visitation was based on existing visitation use estimates at the Nimbus and Feather River hatcheries. (In FY 1974 visitation use at the Nimbus and Feather River hatcheries totaled 81,600 and 101,300, respectively.) Initial recreation days of hunting at the reservoir are estimated to be 5,000. For the purposes of this appendix, reservoir fishing is considered a general recreational activity.

The maximum number of people who could use the facilities at the lake in one day without degrading the areas is estimated to be about 2,700. The ultimate design day figure for use of hatchery visitation facilities is 1,800.

SECTION V

RECREATION MARKET AREA AND ATTENDANCE - LOWER YUBA RIVER

21. Recreation market area and population. -

The river portion of the project is considered to have a market area of 50 miles (Figure D-4), although there will be some use from more distant origins. Based on recent data collected by the Corps of Engineers and Sacramento County concerning recreation use on the American River in the vicinity of Sacramento during the summer of 1975, it is anticipated that over 80 percent of the river users would originate from within a 50 road-mile distance from the river. The geographic boundary of the market area was established by including the adjacent census divisions with major population centers located within 50 road-miles of the nearest access site on the Yuba River. Population estimates for the market area for the period 1990 to 2020 are based on California Department of Finance Population Projections, Alternative Series D-100.(5) From 2030 to 2090, population growth is expanded at a rate of 1.1 percent per year. The following tabulation shows the estimated market area population in 1975 and for each decade from 1990 to 2090.

Year	Population	Year	Population	Year	Population
1975 -	345,000	2020 -	535,000	2060 -	813,000
1990 -	369,000	2030 -	594,000	2070 -	902,000
2000 -	425,000	2040 -	660,000	2080 -	1,001,000
2010 -	482,000	2050 -	732,000	2090 -	1,120,000

22. Recreation opportunities. -

At present, recreation use of the lower Yuba River, and other rivers and streams within the market area, is severely limited by the lack of public lands and access. Construction of the Marysville Lake project will increase the recreation potential of the lower Yuba River by stabilizing flows and enhancing fishery resources. Maintenance and improvement of the river's natural resources is planned as a mitigation feature to offset expected damage due to inundation by the new lake. A hatchery and other measures will provide substantial salmon and steelhead fishery enhancement, and this will contribute to the river's recreation potential. However, to accrue the benefits to be derived from the river's recreation potential, adequate public lands and facilities must be provided to afford public access to the improved river recreation resources.

23. Recreation development alternatives. -

There are two basic alternatives for recreation development along the improved lower Yuba River: (1) optimum plan - provide for access to the river at selected sites and develop a biking and hiking trail along the 14-mile reach of the river from the city of Marysville to the afterbay dam; and (2) recommended plan - to provide for access to the river at selected sites. With access to the river at selected sites, the public could reach the river at those locations and fish, boat, and participate in other activities on the river itself, in addition to limited picnicking and other day uses at the access points.

24. Estimates of recreation attendance. -

Estimates of recreation attendance for the lower Yuba River were derived by adjusting the recorded use of a similar project (the American River Parkway) for dissimilarities between projects. Adjustments were calculated by the use of proportions to account for differences in market area population, available recreation land, and the anticipated level of recreation development. Differences in aesthetic qualities, river flows, and population distribution were also considered in arriving at the final use estimates.

Four access sites would be constructed initially and each site, except Daguerre Point, would provide 20,000 recreation days initially; Daguerre Point would contain additional facilities and would provide 40,000 recreation days initially. Additional facilities and access areas would be developed to accommodate the additional future use expected, as discussed in paragraph 27.

The projected recreation participation, in thousands of recreation days, for the lower Yuba River is tabulated below.

Year	Recommended Plan	Optimum Plan
1990	95	130
1993	100	140
2000	110	150
2010	120	170
2020	135	190
2030	150	210
2040	170	235
2050	185	260
2060	205	290
2070	230	320
2080	255	355
2090	300	400

The ultimate design day load for lower Yuba recreation facilities is 2,700.

SECTION VI

RECOMMENDED DEVELOPMENT PLANS AND ALTERNATIVES

25. Development plans. -

This section discusses three recreation development plans: (1) the recommended plan, (2) the alternative optimum plan, and (3) the single-purpose recreation alternative plan. The basic elements of these plans have been previously discussed in paragraph 4.

26. Recommended plan - lake area. -

It is proposed that a minimum development plan be implemented at the lake since there is no non-Federal sponsor to cost-share under the provisions of Public Law 89-72. Under these circumstances, the Corps of Engineers would construct only minimum facilities to protect public health and safety. In addition, it is anticipated that a concessionaire would provide certain services to the public, such as a marina. As discussed in paragraph 20, an estimated 150,000 recreation days of annual use would be accommodated under this plan, including about 10,000 recreation days at each of 13 road-ends that will be inundated by the new lake (Figure D-7). Day-use facilities would be provided in conjunction with the interpretive facilities at the hatchery. The project includes a visitor center and museum; however, no specific recreation day use was assigned to these facilities since it is projected that those sightseers

using these facilities would also use other project facilities. Also, the development plan would include relocating existing Englebright Lake recreation facilities inundated by the Marysville Lake gross pool and, as previously noted, the above use does not include use of these facilities. Development includes the following facilities per road-end:

- 25 Vehicle parking spaces
- Turnaround area
- 2 Portable chemical restrooms
- Safety barriers
- Signs
- Fencing

The above minimum facilities would be located at each of the following road-ends (Figure D-7):

(1) Downey - Gunning Road

(2) Highway 20, west of Smartville

(3) Road north of Smartville (School Road)

(4) Road to Sucker Flat (west)

(5) Road to Sucker Flat (east)

(6) Bridgeport - south side

(7) Bridgeport - north side

(8) Bald Mountain Road

(9) Township Road - main road

(10) Township Road - north fork access road

(11) Township Road - central fork access road

(12) Township Road - south fork access road

(13) Peoria Road

If development at Englebright Lake follows the 1975 Master Plan schedule, 60 boat-in campsites and 100 boat-in picnic sites would remain above gross pool at Englebright Lake after Marysville Lake is completed. Two 2-lane boat ramps, 15 boat-in campsites, and 20 boat-in picnic sites would be inundated. The boat ramps would be extended to accommodate boaters at the higher pool elevation and the inundated boat-in sites would be relocated at various locations above gross pool (Figure D-7).

27. <u>Recommended plan - lower Yuba River</u>. -

Analyses of the suitability of the project to accommodate various activities and the desires of local governments were considered in developing the recreation plan for the lower Yuba River. Activities to be accommodated include shore and boat fishing, rafting, and unstructured general recreation (i.e., picnicking, swimming). Four public access locations would be located on the right bank of the Yuba River initially (Figure D-6B). Each access area except Daguerre

Point, would have a gravel parking area for approximately 25 automobiles, 4 picnic tables, provision for car-top or small-trailer boat launching, and portable chemical restrooms (Figure D-8). Daguerre Point would have parking for 50 automobiles (2 gravel parking lots), 8 picnic sites, drinking water, an interpretive shelter, and 6 portable chemical toilets.

Estimates of recreation use are presented in paragraph 24. To accommodate increasing public use during the first 60 years of projected operation, the facilities at each of the four initially developed sites would be increased two-fold on an "as needed" schedule. Beyond 60 years, two additional sites would be developed with facilties similar to the initial sites, when there is a need for additional capacity.

28. Optimum level recreation development - lake area. -

The optimum recreation development plan would fully utilize the recreation potential associated with the lake and would accommodate 350,000 recreation days of initial annual use and 1,000,000 ultimately. Most of the recreation facilities would be developed in initial and future stages at five areas: Gatesville Recreation Area, Township I Recreation Area, Township II Recreation Area, Bridgeport Recreation Area, and McGinn Creek Recreation Area (Figure D-6A). Also, boat-in areas would be located at a number of points around the lakeshore; a visitor's center would be developed in conjunction with the project office on Howard Hill; and day use facilities would be developed in conjunction with the interpretive facilities at the fish hatchery. Recreation facilities

above gross pool at Englebright Lake would be utilized, and those inundated would be relocated (see paragraph 26). The following tabulation lists major facilities to be developed at the lake in the optimum development plan.

Area	Development	Initial	Future
Gatesville	Camping		100 sites
	Picnicking	50 sites	50 sites
	Boat launching	4 lanes	4 lanes
	Beach	1 area	
Township I	Camping	150 sites	150 sites
Township II	Camping	50 sites	50 sites
	Picnicking	100 sites	100 sites
	Boat launching	4 lanes	8 lanes
	Beach		1 area
Bridgeport	Camping	25 sites	
	Picnicking	15 sites	
McGinn Creek	Camping		100 sites
Boat-in	Camping	45 sites	20 sites
	Picnicking	20 sites	
Englebright	Camping	60 sites	
	Picnicking	100 sites	
	Boat launching	4 lanes	

Total initial development with this plan would include 330 campsites, 285 picnic sites, 12 boat lanes, and 1 beach. Ultimate development would consist of 750 campsites, 435 picnic sites, 24 boat lanes, and 2 beaches.

The following tabulation indicates what percent of the daily lake visitors would be participating in the major recreation activities. The sum of the percentages exceeds 100 percent since some lake visitors can be expected to participate in more than one activity.

Activity	Percent Use
Camping	25%
Picnicking	40%
Boating	40%
Fishing	15%
Swimming	30%

The optimum plan also includes such support facilities as access and circulation roads, parking, restrooms, water supply and distribution systems, electrical supply systems, sewage disposal and collection systems, and landscaping. Two marina facilities would be developed and leased for operation to concessionaires; one marina would be developed initially at Township II Recreation Area, and one would be developed in the future at Gatesville Recreation Area.

Trail systems would be developed for use by both pedestrian and equestrian recreationists. The specific location of trail systems would be designed during master plan studies. Consideration would also be given to bicycle trails during master plan studies.

Entrance stations would control access at each recreation area. From these entrance stations personnel would provide information to visitors and collect fees as well as prevent overcrowding of the day use and overnight recreation facilities. Project interpretive facilities would be located at the visitor center which would be constructed as part of the project offices on Howard Hill overlooking the lake (Figure D-6A). Space would be provided for a museum, multi-media presentations, and interpretive programs for various project-associated natural resources, cultural resources, and project purposes and benefits.

29. Optimum level recreation plan - lower Yuba River. -

Access points and facility development would be similar to the previously described recommended plan but would include a bikeway along the right riverbank for 14 miles from the afterbay dam to the confluence (Figure D-6B). Additionally, the optimum plan would be developed at a faster rate to accommodate the anticipated increased use under the optimum plan.

30. Single-purpose recreation alternative plans. -

Two single-purpose recreation alternatives were developed for cost allocation purposes; they would not be constructed by the Corps of Engineers. One is a relatively inexpensive river corridor development that would provide an amount of recreation equal to the selected plan, although not providing the full range of activities as the recommended plan and not having the capability for future expansion to provide the same amount of future recreation use as in the recommended plan. The recreation activities provided by this alternative would be river-oriented activities which are in great demand in the State. The second alternative is a river corridor and lake development that would be considerably more expensive but would provide an amount of recreation equal to the recommended plan, having the same full range of lake-oriented activities and including the same capability for expansion as in the recommended plan.

a. Single-purpose river corridor alternative. - This alternative would consist of the six river access areas, and environmental corridor on the 14-

mile Yuba River reach downstream from the afterbay site, as described in the lower Yuba River optimum recreation plan which would accommodate 300,000 recreation days annually, and three additional access areas on the 9-mile reach upstream from the afterbay site to Englebright Dam. The three upstream access areas would provide approximately 150,000 recreation days of recreation use, the same as the lake recreation use expected for the recommended plan of development at the lake.

b. Single-purpose river corridor and lake alternative. - This alternative would consist of a lower Yuba River corridor and dam and lake at the Browns Valley site. The alternative would have the capability to provide the same recreation potential as the recommended plan. The lake would have an average recreation pool of about 7,600 surface acres, and recreation development would be the same as the development at 13 road-ends in the recommended plan, to accommodate 150,000 recreation days annually ultimately. Five access areas, a bikeway, and environmental corridor would be developed on the lower Yuba River below the dam. The five access sites would be enlarged in the future to accommodate 300,000 recreation days ultimately, similar to the recommended plan. Although this alternative has a considerably higher cost than the other alternative, it would provide the same full range of recreation opportunities as the recommended plan and would have the same recreation potential as the recommended plan. It is, therefore, the single-purpose alternative used in cost allocation studies.

SECTION VII - FISH AND WILDLIFE MANAGEMENT PROGRAMS

31. General. -

Fish and wildlife enhancement constitutes a specific purpose for which the Marysville Lake project was authorized by Congress. There are two major fish and wildlife programs to be implemented: enhancement and mitigation. The enhancement program consists of features which will add more to the resource and the public use opportunities of the resource than would exist without the project. The mitigation program consists of determining project-related damages to the existing resources and reasonable and justifiable measures which should be accomplished to prevent, reduce, offset, and mitigate such damage.

The project provides for fishery enhancement of 70,000 salmon and 10,000 steelhead by construction of a hatchery, spawning channel, and improvement of river gravel spawning areas. This enhancement is made feasible by the better flow regulation afforded by the project. In addition, the new lake is expected to provide warm-water and cold-water fishery enhancement. The recreation development plan for the lower Yuba River would provide general recreation and fishery enhancement, and a number of other incidental enhancement aspects are expected as spinoffs from various project features. Public access facilities for general recreation and the fish planting and fishery regulatory programs conducted by the California Department of Fish and Game for all of the State's waters would assist in this enhancement. Enhancement measures are discussed in paragraph 33b.

The new lake, dams, and other project features would destroy or otherwise alter portions of the Yuba River and tributaries and associated land areas which contain fish and wildlife resources. Mitigation measures to prevent or replace these losses are discussed in paragraph 33a.

32. Investigations. -

Through a comprehensive coordination program, the Corps of Engineers has involved three expert agencies to investigate both enhancement and mitigation aspects: the Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Game. Also, an expert consultant, BEAK Consultants, Inc., was engaged to review all available information, conduct additional studies, and prepare a separate evaluation of enhancement and mitigation aspects. Results of these studies are presented in the following sources which have been utilized in preparing the Phase I GDM and this Appendix:

- Exchanges of correspondence between the agencies providing data on individual items.

- Updated report by Fish and Wildlife Service, dated 21 December 1976 (included in Appendix B).

- BEAK Consultants, Inc., report dated Summer 1976.

A preliminary plan for enhancement and mitigation of fish and wildlife resources influenced by the project is described in the following paragraphs together with the land requirements for implementing this plan.

33. <u>Fishery resources, mitigation, and enhancement</u>. -

There are important anadromous and resident fish species in the Yuba River and Englebright Reservoir. The Marysville Lake project is self-mitigating with measures incorporated in the project to augment streamflow, preserve river habitat and riparian vegetation, and maintain optimum water temperatures. In addition to these measures planned to maintain existing fishery resources, enhancement measures are planned to increase fishery resources in the downstream river system and at the new lake.

A comparison of with and without project conditions indicates that the project, including enhancement and mitigation features, would have several beneficial effects on fisheries and little or no adverse effects. Overall, by including mitigation measures described below, detrimental effects of the project on the existing anadromous fisheries of the Yuba River would be negligible. Generally, the loss of spawning and rearing habitat utilized by potential runs of 6,000 salmon and 2,500 steelhead resulting from inundation by the project would be offset by flow stabilization, temperature regulation, and river habitat maintenance and improvement. This would result in about the same salmon and steelhead populations of 50,000 and 2,500 fish, respectively, being produced following dam construction as under conditions without the

project. Provision for future enlargement of capacity would be incorporated in the enhancement fish hatchery discussed in paragraph 33b to produce the equivalent of 6,000 adult salmon and 2,500 adult steelhead, if necessary, in the event that operational experience shows the other mitigation measures are not completely effective.

Colder water releases from New Bullards Bar Dam (since 1970) have caused a decline in the American shad population. The Marysville Dam should have no direct adverse effect on this declining population; however, the downstream flows and temperatures can be manipulated to contribute to the success of the shad run. The project is expected to have little impact on the striped bass populations.

The project would result in a loss of approximately 10 miles of stream fishery on the Yuba River for resident cold- and warm-water species. However, the remaining lower Yuba River would have improved capability for an expanded resident trout population due to better flow conditions expected with releases from Marysville Lake. In addition, it is anticipated that a warm-water fishery would be established in the new lake, providing many times the number of fish presently inhabiting the Yuba River and tributary streams inundated and supporting many times the amount of fishing. Increased populations of trout and Kokanee salmon can also be expected at the new lake.

a. Mitigation. - Fishery mitigation features to be implemented as a part of the Marysville Lake project include meeting downstream minimum flow requirements, controlling water temperatures of releases by means of a

multiple-level intake, and acquiring riparian lands and spawning gravel areas from the afterbay dam to the mouth of the Yuba River and from the Dry Creek dam to the mouth of Dry Creek. These features are described in more detail in the following paragraphs.

Operation of the Marysville Lake project would be designed specifically to provide downstream flows recommended for fish throughout the year, and particularly during salmon and steelhead spawning and migration periods. The U.S. Fish and Wildlife Service has recommended at least 800 cfs at the mouth of the Yuba River from October through January, 1,000 cfs in February through April, and 600 cfs in May through September, and these releases would be provided. In addition, for maintenance of fish and wildlife resources of Dry Creek, Dry Creek dam would be equipped with an outlet structure to provide a minimum year-round flow of 10 cfs and occasional higher flows up to 100 cfs. Such flows in both waterways would maintain conditions suitable for the downstream fisheries as well as the adjacent riparian vegetation which provides habitat for fish. Operation studies indicate that these recommendations would be met or exceeded in all but a few months during dry years when water supply deficiencies occur.

The multiple-level intake structure at the Yuba River dam would provide controlled water temperatures highly suitable for anadromous salmon and steelhead and resident fish species. The U.S. Fish and Wildlife Service has recommended that the following maximum temperatures not be exceeded in the periods indicated.

Temperature	Monthly Range
60°F	1 Oct - 15 Oct
55°F	15 Oct - 31 Mar
60°F	1 Apr - 15 May
65°F	16 May - 31 May
70°F	1 Jun - 15 Jun
72°F	16 Jun - 15 Sep
70°F	16 Sep - 30 Sep

Water temperature simulation studies conducted by the Waterways Experiment Station indicate that the Marysville Lake project would meet these temperature requirements(10). These studies are reported on in Appendix G. Additional studies will be conducted during preparation of subsequent design memorandums to optimize design of the multiple-level intake facility to assure that temperature requirements are met.

Lands that contain spawning gravels and adjacent riparian habitat would be acquired as a part of the project to prevent future losses of river lands to dredging operations and development and would be an important element in the overall program for mitigation of fish and wildlife habitat loss in the lake area.

b. Enhancement. - With the implementation of enhancement measures, fishery resources of the Yuba River and lake area would be increased. Enhancement measures to be implemented as a part of the Marysville Lake project to achieve this increase include: hatchery and spawning channel construction, stream channel management, and reservoir management. These measures are discussed briefly in the following paragraphs.

A feature design memorandum will be prepared to describe the hatchery and gravel improvements in detail. Cost estimates for the Phase I General Design Memorandum include $16,700,000 for the hatchery, gravel improvements, and support facilities such as access road, water supply, and public use facilities.

Examination of the flow regime provided by the project indicates that a salmon and steelhead hatchery to enhance the anadromous fishery would be feasible. The hatchery would be constructed downstream from the afterbay, as recommended by the Fish and Wildlife Service and the California Department of Fish and Game (DFG) in a letter dated 26 July 1976. The hatchery would be designed to provide enhancement runs of 50,000 salmon and 10,000 steelhead, and would include provisions for a future additional 6,000 salmon and 2,500 steelhead if necessary for mitigation, as discussed above.

The DFG also indicated that additional enhancement could be realized by improving spawning gravels in the river and providing a special spawning channel. The report of BEAK Consultants, Inc. indicated that spawning gravel improvement could produce enhancement of about 20,000 salmon(1). It appears that flow regulation by the project would permit such improvement. Stream channel management would be implemented to preserve and improve fish habitat downstream from the project. The program would include periodic removal of streamside vegetation that has encroached onto important spawning area, periodic gravel rehabilitation to remove silts and combat compaction, and replenishment procedures. A spawning side channel would be constructed as part of the gravel rehabilitation and replenishment program.

Several enhancement measures would be taken for the fishery in Marysville Lake. Trees and other vegetation would be left in place in selected areas below gross pool to provide habitat for resident warm-water fish. In addition, in establishing reservoir operation criteria, consideration would be given to lake level management to minimize reservoir fluctuation during a 4- to 8-week period in the early summer to maximize warm-water fish spawning success. Adequate fish restocking programs and possibly rough fish eradication programs also would be accomplished by the California Department of Fish and Game.

34. Wildlife resources. -

The Marysville Lake project is located in oak woodland, grassland, and chaparral habitat types, interspersed with riparian habitat along stream courses. The project area is occupied by about 60 species of mammals, 213 bird species, 20 reptile species, and 9 amphibian species. The more important species specifically considered in planning are discussed below. Although these species represent only a small portion of the total wildlife resource, they provide an indication of the effect of the project on the total resource and of the habitat requirements to be considered in mitigation. Mitigation measures are discussed in paragraph 35.

a. Deer. - Both migratory and resident herds of Columbian black-tailed deer occupy the project area. The 7,300 acres of habitat adversely affected by inundation, construction, and operation of the project are estimeted to support about 423 resident and 180 migratory deer(1).

Neither figure is highly reliable statistically, but they are presented here as working figures to help quantify mitigation needs. These estimates do not reflect deer population changes that may occur in the future due to influences other than construction of the Marysville Lake project. Current development trends suggest that a 30 percent decrease in deer populations may occur without the project. This would decrease the estimate of impacted resident and migratory deer population to about 422 deer. Hunters currently harvest an estimated 21 deer annually from the project area(1). This harvest represents only a small portion of the potential harvest the area could support if there were adequate public access and if more liberal hunting regulations were adopted; however, future hunting trends will probably be toward less hunting use(1). Nonhunting uses of deer (e.g., nature study) are also currently restricted in the project area: such uses may increase slightly without the project. Marysville Lake would increase nonhunting uses significantly above without-project-levels through increased public access and the people it would attract to the project area.

b. Waterfowl. - The Central Valley supports 26 species of waterfowl; each of these 26 species may occasionally inhabit the project area. Presently the project area offers some nesting areas on ponds and riverbanks, but it does not offer adequate nesting and feeding areas to attract large numbers of waterfowl. Marysville Lake would provide a large body of water attractive as a resting area which would be used by some waterfowl traveling from valley feeding areas.

c. Wild turkeys. - The project area supports an estimated 200 wild turkeys. About 100 of these birds would be lost due to habitat inundation by the project; however, even without the project, the turkey populations are likely to decline due to future development influences. (1) The estimated 100 turkeys inhabiting the area to be inundated by the project likely would be decreased by about 20 percent due to future development. It seems possible that future development would eventually eliminate the entire population by 2040 (1), but the 80-turkey estimate is used as a reasonable mitigation requirement.

d. Quail. - The portion of the project area that would be inundated by the lake supports about 2,500 California quail. (1) California quail are the most abundant upland game species in the project area; they are tolerent of human activity and could continue, although at somewhat reduced numbers, even if the project area were developed to low density (40-acre parcels) residential use (without project conditions). Loss of riparian vegetation inundated by Marysville Lake would reduce quail populations, and low density project recreation development adjacent to the lake would also reduce affected populations somewhat.

e. Nongame birds. - The 7,300 acres of project lands to be inundated by the lake or used for construction of the dams support about 213 bird species. About 180 of these species represent nongame species. The season and the amount and kind of available habitat govern the specific population densities of these nongame species. Riparian habitat typically supports the highest population

densities of nongame birds. Estimates of population of nongame birds in the area to be inundated range from about 74,000, comprising 87 species, down to about 16,000.(1) These estimates of numbers of birds, coupled with the acres of habitat of various types, are the most important consideration.

35. Wildlife mitigation plan. -

Several measures have been planned to mitigate for project-related losses of riparian habitat and other habitat for deer and other wildlife both adjacent to and removed from the lake to increase wildlife populations. The measures would offset project-related losses by habitat improvements to increase habitat carrying capacity and by preserving nearby habitat areas threatened by land use changes. Another important consideration is an evaluation of the current habitat quality of the inundated and the to-be-acquired mitigation acreage, as well as probable future conditions of the habitat without the project. The mitigation measures proposed by the Corps would utilize 16,370 acres as described below. The tabulation at the end of this paragraph summarizes losses and gains to lands and particular species with the project.

The project includes the following wildlife mitigation measures: (a) increase the wildlife carrying capacity of 7,500 acres of multipurpose project lands by about ten percent; (b) acquire and improve 630 acres adjacent to the lake for turkeys and other wildlife species; (c) increase the wildlife carrying capacity of the 2,620 acres of government-owned lands

which are principally dredger tailings on the Yuba River downstream of the afterbay -- this would achieve an equivalent wildlife habitat improvement of about 600 acres since the majority of the area is low quality gravel dredger tailings; (d) increase the wildlife carrying capacity on 800 acres of the lower Yuba River and 820 acres of lower Dry Creek; (e) increase the wildlife carrying capacity on 1,000 acres of the State-owned Spenceville Wildlife and Recreation Area by about one-fourth; (f) acquire 3,000 acres of land in the Hackett Creek area in Nevada County adjacent to the Spenceville Wildlife and Recreation Area and increase its wildlife carrying capacity by one-fourth, and (g) construct 10 one-acre detention reservoirs in the designated mitigation acreage of the Hackett Creek area, the multipurpose project lands, and the Spenceville Wildlife and Recreation Area. The following paragraphs provide detailed information on each of the wildlife mitigation measures.

a. Project lands and Spenceville Wildlife and Recreation Area. - The wildlife carrying capacity of 7,500 acres of multipurpose project lands would be increased by about 10 percent by closely controlling and managing competing uses, such as cattle grazing activities, on those lands. At present, livestock grazing prevents development of vegetation important as food and cover to wildlife species. Also, the wildlife carrying capacity would be increased on 1,000 acres of the Spenceville Wildlife and Recreation Area (Figure D-9) by one-fourth by providing for improved cattle grazing activities, planting important wildlife vegetation, managing key wildlife species, and providing additional water sources.

b. Wildlife management lands adjacent to Marysville Lake. - The Corps plans acquisition and habitat improvement and management of 630 acres of land on the southern boundary of the lake (Figure 6A). These lands presently provide turkey habitat and would be improved and managed primarily for turkeys, although they would be enhanced for other wildlife species as well.

c. Dredger tailings. - Dredger tailings on 2,620 acres of government-owned lands (Figure 6B) downstream of the afterbay currently support only limited vegetation. The wildlife carrying capacity of 600 acres of these lands interspersed throughout the larger area would be increased by grading the steep gravel banks adjacent to the ponds to encourage growth of riparian and upland vegetation by creating a more favorable land-water interface. Desirable vegetation would be planted and native species allowed to volunteer to create added wildlife habitat.

d. Lower Yuba River and lower Dry Creek. - The wildlife carrying capacity on 800 acres of land along the lower Yuba River (Figure 6B) and 820 acres of land along lower Dry Creek (Figure 6A) would be improved. The ribbons of riparian vegetation along the banks of the lower Yuba River and lower Dry Creek already provide prime wildlife habitat, and, with increased flood protection and fewer destructive floods, increased riparian growth will be encouraged. Also, acquisition of these lands and the institution of protective measures will encourage retention of volunteer native species which otherwise would be lost to local activities such as cattle grazing. Wood duck nesting boxes would be

provided to supplement the nesting sites already available for wood ducks and other wildlife species that use above-ground nesting sites. Small numbers of nesting sites will also be provided for raptors such as ospreys and eagles along these two watercourses and possibly at other locations on project lands.

e. Hackett Creek area. - The Hackett Creek area (Figure D-9) is key wildlife habitat, and 3,000 acres of land would be acquired in this area and its wildlife carrying capacity increased. These lands currently support wintering populations of over 200 wild turkeys, wintering populations of Columbian black-tailed deer, and large populations of other wildlife species throughout the year. Based on estimated deer densities of lands in the project area, the 3,000-acre Hackett Creek area supports an estimated 275 deer; however, this may be conservative, and the area may support as many as 400 deer. The Hackett Creek area is currently zoned for 5-acre minimum parcels and is subject to residential development. A developer has acquired an area in Yuba County adjacent to the Hackett Creek area, and it appears the Hackett Creek area may also be developed if it is not acquired for public use, such as for wildlife mitigation for the Marysville Lake project. Residential development of the Hackett Creek area would eliminate the turkey and deer populations and reduce other wildlife populations.

If Hackett Creek, or a similar area, is not acquired for mitigation, it would be necessary to acquire a larger area of less important habitat to

provide an equivalent mitigation value, as identified by the Fish and Wildlife Service. Acquisition of key habitat, such as the Hackett Creek area, is the less expensive alternative. Thus, acquiring this area for wildlife mitigation for the Marysville Lake project would be in the best interests of the project and the State and Federal agencies charged with fish and wildlife responsibilities. The wildlife habitat of this area would be improved by one-fourth by halting livestock grazing, planting vegetation that would provide food and cover for deer and other wildlife species and providing additional water sources.

f. Detention ponds and waterfowl habitat. - Ten 1-acre detention reservoirs would be constructed in the Hackett Creek area, on improvable project lands, and the Spenceville Wildlife and Recreation Area to provide a source of water for wildlife species of the mesic habitat in these areas. These ponds would be constructed in a manner similar to the numerous farm ponds and similar small water storage areas found throughout California that are encouraged and supported by the U.S. Soil Conservation Service. If measures are taken to prevent excessive seepage, entrapped rainwater and runoff should fill these small ponds. Also, specific habitat benefits could be gained for waterfowl by providing about 8 acres of riparian vegetation at these ponds useful for waterfowl feeding and nesting.

Mitigation plan element	Total area (acres)	Riparian habitat (acres)	Conceptual representation of numbers of key wildlife species			
			Quail	Turkey	Non-game birds	Deer
<u>Lands not specifically acquired for fish and wildlife</u>						
Multipurpose lands at lake	7,500		1,500(4)		15,000(8)	285(11)
Govt. owned lands below afterbay	2,620(1)	20	524(4)		90(9)	40(13)
<u>Lands specifically acquired for fish and wildlife</u>						
Turkey mitigation lands	630		126(4)	20(6)	1,260(8)	12(12)
Lower Yuba River lands	800(2)	200	760(5)		920(9)	
Lower Dry Creek lands	820	150	570(5)		690(9)	
Hackett Creek lands	3,000	30	600(4)	150(7)	3,000(10)	300(12)
Spenceville lands (by special agreement)	1,000(3)	20	200(4)		90(9)	55(14)
<u>Total mitigation</u>	16,370	420	4,280	170	21,050	692
<u>Total loss to be mitigated</u>(15)	7,540	280	3,433	100	18,511	603
(Inundation and construction and operation)	7,300	280	3,300	80	15,540	603
(Recreation)	240		133(16)		2,971(17)	

(1) Contains 600 acres of improvable land.
(2) Includes land area only. There is an additional 880 acres of water area acquired for fishery purposes.
(3) Title of land will remain with the California Department of Fish and Game.
(4) Based on one quail/5 acres increase on nonriparian lands.
(5) Based on 3.8 quail/acre increase on additional riparian vegetation added.
(6) Based on a 20 percent increase in turkey population.
(7) Based on loss of 75 percent of the turkey population (200) under without project conditions.
(8) Based on 2 birds/acre increase.
(9) Based on 4.6 birds/acre in additional riparian vegetation added.
(10) Includes one bird/acre that would be lost to land use changes.
(11) Based on 10 percent increase for area with 60 deer/section (72) and a 30 percent decrease under without project conditions (213).
(12) Based on 25 percent increase in present population of 300 deer (+75) and a 75 percent decrease under without project conditions (225).
(13) Based on 25 percent increase in present population (160 at 38 deer/section).
(14) Based on 25 percent increase in present population (220).
(15) Includes lands inundated (6,900 acres), construction and operation lands (400), minimum development recreation lands at 13 locations (130 acres), six recreation access sites on the lower Yuba River (110 acres).
(16) Based on .056 quail/acre in oak woodland habitat (100 percent loss) and 3.8 quail/acre in riparian habitat (30 percent loss - most development would occur in barren areas).
(17) Based on 12.5 birds/acre in oak woodland habitat (100 percent loss) and 40.8 birds/acre in riparian habitat (30 percent loss - most development would occur in barren areas).

36. Wildlife enhancement plan. -

A wildlife enhancement area on lands of the project was studied, but was found to be impractical as a project feature. Data herein are included as a matter of information. The Fish and Wildlife Service (FWS) indicated, in their letter of 21 December 1976, that a significant waterfowl enhancement potential exists in the vicinity of the project. The proposed enhancement plan would have been located in the vicinity of Reeds Creek, south of the project, and would have consisted of creating about 60 ponds ranging in size from one to 140 acres. These ponds would result in the establishment of about 460 acres of permanent freshwater marsh and would permit growth of about 50 acres of riparian habitat. Such marshes constitute important production areas for waterfowl as well as feeding and resting areas for migratory birds. Based on counts of waterfowl use at an existing pond in the area, the habitat established along Reeds Creek would support 4,000,000 waterfowl use days during the migration period. Other migratory and nonmigratory birds would also utilize the new habitat.

The enhancement plan would require acquisition of about 1,200 acres of privately-owned land, together with development on about 300 acres of land on Beale AFB. The enhancement area is immediately north and east of the Base runway. Recent coordination with Beale AFB indicates that increasing bird populations in the vicinity of the Base would increase the accident hazard; several incidents have occurred in the past. Accordingly, the waterfowl enhancement plan is not recommended for implementation.

37. U.S. Fish and Wildlife Service (FWS) reports. -

FWS prepared a detailed Fish and Wildlife report for the Marysville Lake project for the Browns Valley site at the time of project authorization in 1966. Since that time, FWS provided additional data for the Browns Valley site and the Parks Bar site. FWS prepared two planning aid letters for the Marysville Lake project at the Parks Bar site: one dated 13 May 1976, and the other dated 21 December 1976, which supplemented and amended the initial letter. These letter reports are included in Appendix B.

Significant differences between FWS recommendations in their 21 December letter and fish and wildlife features included in the Marysville Lake project as presently formulated are as follows:

a. FWS indicated that a total of 20,865 acres of land is needed for wildlife mitigation. The Corps feels that 16,370 acres of improved and managed lands will offset wildlife losses resulting from the project as shown in the tabulation on wildlife mitigation.

b. FWS does not agree that the project is self-mitigating for the salmon and steelhead spawning area and rearing habitat inundated by the lake. The area inundated supports spawning populations of 6,000 salmon and 2,500 steelhead and provides nursery area for fingerlings prior to their downstream migration. BEAK and the Corps of Engineers believe that temperature and flow regulation combined with other measures discussed in paragraph 33 will mitigate

the losses. However, the hatchery would be designed so that additional capacity could be added to produce the equivalent of up to 6,000 adult salmon and 2,500 adult steelhead in the event that operational experience shows the other mitigation features are not completely effective.

c. FWS recommends development of an improved fishery at the lake through expansion of hatchery facilities, initial stocking of cold- and warm-water species, and construction of angler use facilities under the requirements of PL 89-72. At this time the State of California has not indicated an interest in cost-sharing for enhancement of fishery resources at the lake, and no non-Federal public agency has indicated an interest in participating in recreation development at the lake. The minimum facilities to be provided for public health and safety should provide the needed angler use facilities suggested by FWS, and it is anticipated that standard stocking of fish by the State for all its waters would provide an adequate fishery for Marysville Lake. No hatchery expansion or other facilities for lake recreation and fish and wildlife enhancement would be provided unless a non-Federal agency participates.

d. FWS does not recognize in their report that gravel management and spawning channels are viable fishery enhancement measures and should be implemented, although the California Department of Fish and Game, BEAK, and the Corps of Engineers endorse these features. The FWS will administer the fish hatchery and related fishery enhancement features of the project.

38. Fish and wildlife monitoring and analysis. -

The numbers of wildlife found in the project area in studies to date are the best information available, but are preliminary estimates. Mitigation and enhancement concepts and programs have been developed on the basis of the preliminary estimates, with the understanding that further studies would be made to confirm or change the estimates, as appropriate, and that any changes in mitigation programs indicated by the new data would be made prior to implementation. The numbers of salmon and other fish found in the project area now and in the future are also preliminary estimates. For salmon, there are four separate programs and estimates, as follows.

a. It is estimated that the Yuba River would produce a potential 50,000 adult salmon and 2,500 adult steelhead without the project.

b. It is estimated that the potential loss from the dams and lakes of about 6,000 existing and future potential adult salmon and 2,500 steelhead and associated rearing space for young salmon would be mitigated by project features such as temperature control, improved flows, gravel preservation and others; however, it is also planned to expand hatchery facilities to produce the 6,000 salmon and 2,500 steelhead if the self-mitigating features are not completely effective.

c. It is estimated that a 50,000 adult salmon and 10,000 adult steelhead enhancement would result from the hatchery.

d. It is estimated that 20,000 adult salmon, and perhaps considerably more enhancement, would result from gravel management and associated spawning channel.

To identify the separate contributions from these programs during project operation, a program will be established to compare preproject and postproject conditions (i.e., one salmon cannot be distinguished from another unless special studies are made, such as fin-clipping and others). Without such monitoring and analysis, the efficiency and efficacy of the various features constructed by the Corps could not be explained if criticism or questions arise during project operation (e.g., the number of salmon could drop from causes not traceable to the Yuba River or the project since many factors influence the fish during the 3-4 years they spend in ocean waters, etc.).

Some data for the fish and wildlife monitoring and analysis program can be obtained from FWS, the National Marine Fisheries Service, and the California Department of Fish and Game through continuing coordination. Some data can also be obtained from the University of California Sierra Foothill Range Field Station, and from the Corps' lake area manager when the project is in operation. To develop a comprehensive monitoring and analysis program to establish reliable preproject and postproject estimates, a contract would be entered into with an appropriate entity (e.g., University of California, or A-E Consultant, or other) to correlate data gathering, to insure that all needed data are collected, and to collate and analyze the data. The contractor would develop a series of reports furnishing an independent, objective summary and analysis of the

fish and wildlife data monitoring useful for the purposes intended. Costs for this program are estimated as follows:

Preproject data monitoring, analysis, and reports (initiated in Phase II GDM and completed prior to completion of project construction)	$50,000
Postproject data monitoring, analysis and reports (during first several years of project operation)	$50,000
Total	$100,000

SECTION VIII

RECREATION AND FISH AND WILDLIFE LAND REQUIREMENTS

39. General. -

The Marysville Lake project includes about 27,120 acres of land to accommodate the various project purposes, including recreation and fish and wildlife development. About 4,470 acres of these lands are currently under U.S. Government titles, and the remaining 22,650 acres would be acquired from private owners.

40. Recreation and fish and wildlife lands. -

In addition to the lands acquired to serve all project purposes, additional lands will be acquired specifically to accommodate the general recreation and the fish and wildlife needs of the project which cannot be fully accomplished on other project lands. These two land classifications are identified separately; however, it is expected that uses will overlap since in many cases general recreation and fish and wildlife uses are closely related. Other project lands not designated for general recreation and fish and wildlife purposes will also be available for such uses except lands reserved for administrative purposes in the vicinity of the dam, spillway, powerplant and other features. Section VII discusses fish and wildlife management programs which utilize both specifically designated fish and wildlife lands and other project lands.

Project lands specifically acquired for general recreation and fish and wildlife purposes total about 2,200 and 6,130 acres, respectively. Recreation lands at the lake total about 2,035 acres, and lands along the lower Yuba River total about 170 acres. The recommended recreation development at the lake (minimum level for health and safety) does not require specific recreation-designated lands; however, under the Federal Water Project Recreation Act, the Corps of Engineers is permitted to acquire lands necessary to support optimum recreation development at the lake. These lands may be retained for a 10-year period after construction is completed, and if during that period a non-Federal sponsor agrees to participate in recreation development, the Corps of Engineers can participate in such development. If there is no non-Federal sponsor at the end of the 10-year period, the lands may be used for other lawful purposes or disposed of. The 170 acres of land along the lower Yuba River include lands for public access and site development.

The 6,130 acres of lands specifically acquired for fish and wildlife include 1,680 acres in the lower Yuba River corridor; 1,450 acres of wildlife management lands at the lake (820 acres for the lower Dry Creek corridor and 630 acres on the south side of the lake for turkey mitigation lands); and 3,000 acres of wildlife management lands at Hackett Creek. An additional 7,500 acres of multipurpose project lands and 2,620 acres of dredger tailings in the lower Yuba River corridor are included in the wildlife management program (see Section VII). Also, about 1,000 acres of the Spenceville Wildlife and Recreation Area would be improved by the Corps of Engineers and managed by the California Department of Fish and Game for project related wildlife mitigation; this land would remain in public ownership under jurisdiction of the Department of Fish and Game.

SECTION IX - COORDINATION

41. General. -

BEAK Consultants, Inc., a recognized expert fish and wildlife authority, conducted extensive coordination with State and other Federal agencies in the course of their studies related to preparation of their report on "Benefits and Impacts of the Marysville Lake Project on Fish and Wildlife."

Detailed coordination that has been carried out with various agencies concerning recreation and fish and wildlife aspects of the Marysville Lake project is summarized below.

42. Federal. -

a. U.S. Fish and Wildlife Service (FWS). - Coordination is continuing with the FWS to identify fish and wildlife resources of the project area and measures needed for mitigation and enhancement. FWS has indicated recently that they will administer fishery facilities on the lower Yuba River and that such facilities should be constructed at Federal cost. Considerable data in this report has been derived from the extensive information provided by FWS.

b. National Marine Fisheries Service. - Coordination is continuing with National Marine Fisheries Service to supplement the expertise of the FWS

concerning the commercial values and the mitigation and enhancement needs for anadromous fish.

c. U.S. Bureau of Outdoor Recreation. - Informal coordination has been maintained with the Bureau concerning the relationship of the project recreation program to that of the statewide comprehensive outdoor recreation plan.

d. U.S. Bureau of Land Management (BLM). - Approximately 1,725 acres of BLM lands were withdrawn for the Englebright Lake project. These lands and an additional 35 acres of BLM lands would be required for the Marysville Lake project, and coordination will be initiated with BLM to withdraw these lands for the project.

e. National Park Service. - Coordination has been maintained with the National Park Service on studies contracted by the Corps to identify cultural resources in the project area and actions to mitigate loss of cultural resources due to construction of the project.

43. State. -

a. California Resources Agency. - Informal coordination with the Resources Agency indicates no change in their position established in 1971 (see paragraph 3a) that they do not wish to participate in recreation development or administration at Marysville Lake.

b. California Department of Parks and Recreation. - By letter dated 3 June 1976, the California Department of Parks and Recreation indicated that they had no interest in cost-sharing for construction or for operating and maintaining recreation facilities at the project.

c. California Department of Navigation and Ocean Development. - By letter dated 5 May 1976, the Department of Navigation and Ocean Development expressed an interest in providing development funds for boat launching facilities at the lake if another agency would operate and maintain the facilities.

d. California Wildlife Conservation Board. - By letter dated 27 April 1976, the Wildlife Conservation Board expressed an interest in developing access areas along the lower Yuba River.

e. California Department of Fish and Game (DFG). - Coordination with the DFG is continuing regarding fish, wildlife, and recreation aspects of the project. DFG has worked closely with the Federal fish and wildlife agencies in developing extensive data useful for the Marysville Lake project. DFG has indicated they have no interest in sponsoring recreation development at the lake.

f. U.C. Sierra Foothill Range Field Station (SFRFS). - As discussed in paragraph 8, about 1,140 acres, or 20 percent, of the SFRFS lands are required for the Marysville Lake project. This acreage represents a significant

reduction from earlier estimates and is the minimum required. Close coordination has been maintained with SFRFS staff to reduce the adverse impacts resulting from acquiring field station lands. Coordination will continue in an effort to identify mutually acceptable measures to further reduce the impacts.

44. Local. -

a. Yuba County. - Extensive coordination has been conducted with Yuba County. The county indicated by letter dated December 1976 that they do not wish to participate in development or operation and maintenance of recreation facilities at the lake, but that they support public access sites along the lower Yuba River.

b. City of Marysville. - Representatives of the city of Marysville have informally expressed interest in supporting the public access site at the mouth of the Yuba River.

45. Lack of cost-sharing sponsor for recreation development at Marysville Lake. -

Project authorization included recreation and fish and wildlife enhancement as project purposes. The recreation plan originally was based on a letter of intent from the State of California, dated 29 June 1966, stating that the State would provide required cost-sharing and operation and maintenance. However, by letter dated 4 May 1971, the State Resources Agency indicated it would not provide the overall assurances for cost-sharing and operation and maintenance for recreation. Further coordination indicated that some State agencies might participate in limited development, but no non-Federal agency agreed to operate and maintain recreation facilities at the lake. Since non-Federal participation at the lake is lacking, the recreation resources of the project will not be fully utilized and the public use potential will not be developed fully.

This lack of non-Federal participation will limit the overall recreation-resource management program for the Marysville Lake project. A problem of overuse at the lake, similar to those which have occurred at other District-managed lakes, can be expected to occur at Marysville Lake, resulting in some facility and resource degradation. The lack of non-Federal participation will also limit management personnel assigned to the lake.

Lands would be acquired for development of the optimum recreation potential of the lake, and it is anticipated that a non-Federal sponsor may participate in the future when the need for recreation developments is clearly shown. Also, concessionaires are expected to be interested in participating in recreation development in the future after the project is completed.

46. U.C. Sierra Foothill Range Field Station. -

Marysville Lake project would require purchase of about 20 percent of the U.C. Sierra Foothill Range Field Station lands. A portion of the research efforts at the field station are conducted in the area that would be acquired for the project. Coordination has been maintained and will continue with Field Station personnel to attempt to minimize impacts and to identify acceptable measures to offset adverse effects of the project on Field Station lands. Fair market value would be paid for all lands required for the project.

47. U.S. Bureau of Land Management lands. -

When Englebright Lake was constructed, approximately 1,725 acres of Bureau of Land Management (BLM) lands were withdrawn for that project. It is expected that these lands would continue to be withdrawn for the Marysville Lake project. There are about 35 additional acres of land currently administered by BLM that would be required for the project, and it is anticipated that these lands would be withdrawn.

48. <u>Government-owned land</u>. -

The U.S. Government claims 2,620 acres of lands downstream of the afterbay, referred to in this Appendix as "Fish and Wildlife Management Lands - Currently Government Owned" (See Figure D-6B), and Yuba Goldfields, Inc. is currently disputing the ownership (and degree of ownership). Recent Government studies indicate that the Government acquired these lands in the early 1900's for purposes of the Yuba River debris control project under authority of the River and Harbor Acts of 3 June 1886 and 13 June 1902; construction of debris control barriers and associated works was initiated in 1902 and completed in 1935. These lands are largely dredger tailings and riverbeds, and Yuba Goldfields, Inc. has conducted dredger mining operations on some of these lands since the early 1900's.

The Government has informed the company of the ownership claim, and representatives of both parties met in the summer of 1976 to present and discuss their positions. The U.S. Government, supported by the U.S. Department of Justice, claims title without exceptions on some of the lands and title with exceptions for certain degrees of mining rights on the remaining lands. Yuba Goldfields, Inc. contends that they either own or hold valid mining claims to this land. Neither party has acted to resolve this dispute since this meeting. Litigation may be necessary.

49. Corps responsibilities. -

Jurisdiction over all project lands and facilities will remain with the Department of the Army upon completion of construction to insure continuing supervision of all project resources and operation by the Chief of Engineers. The Corps will prepare two Master Plans for the project. One will cover the entire project except developments along the lower Yuba River to guide development and public use as well as conservation of natural resources. The second Master Plan will cover the resources and the recreation and fish and wildlife developments along the lower Yuba River. This Master Plan will be developed jointly with the Fish and Wildlife Service to provide guidelines for development, public use, administration, and conservation of the recreation and fish and wildlife resources. The assistance of Yuba County will also be sought in developing the master plan for the river since Yuba County would participate in development and operate and maintain the public recreation facilities constructed there. Yuba County will also be asked to provide suggestions for the master plan for the remainder of the project.

Activities at the lake related to general recreation and fish and wildlife enhancement and mitigation would be administered, operated and maintained by the Corps of Engineers. It is anticipated that concessionaires would provide certain services for the public, such as a marina. Periodic inspections would be conducted by the Corps of Engineers of all

activities at the project as a part of overall supervision of the project for compliance with Department of the Army requirements regarding project operation.

50. Other Federal responsibilities. -

Specialized fishery production facilities on the lower Yuba River would be administered, operated, and maintained by the Fish and Wildlife Service (FWS), as indicated in letter dated 18 February 1977 from the Regional Director, included in Appendix B. These facilities will be described in the Master Plan or in a feature design memorandum prepared on the fish and wildlife facilities. Recreation access facilities would be developed jointly by the Corps and Yuba County and operated and maintained by Yuba County.

51. State responsibilities. -

About 1,000 acres of California Department of Fish and Game lands (Spenceville Wildlife and Recreation Area) would be improved by the Corps and managed by the Department of Fish and Game for project-related wildlife mitigation. These lands would remain in public ownership under jurisdiction of the State. A number of other normal State activities are anticipated for project lands and waters, as for other areas in the State (fish planting, fishery regulations, etc).

52. Local interests responsiblities. -

Yuba County would provide 50 percent of development costs and maintain and operate recreation lands and facilities along the lower Yuba River. A draft contract identifying Yuba County's responsibilities is included as Attachment A to the General Design Memorandum. Yuba County also would provide certain services and activities at the lake, such as law enforcement, safety, and public health surveillance. A joint fire control program will be agreed upon between the Corps and California Division of Forestry at the lake, and between the Corps, FWS, and the Division of Forestry on the river.

SECTION XII - ENVIRONMENTAL PROTECTION

53. Environmental protection. -

As described elsewhere in this appendix, several environmental mitigation and enhancement features are included in the project and would afford a high degree of environmental quality. Special measures required at project structures, roads, recreation areas, and other areas for environmental quality purposes are described in general below. Further details will be specified in the Master Plan and other appropriate planning, design, construction, and operating documents.

a. Borrow used in construction of the main dams and afterbay dam is currently planned to be obtained from areas that will be below gross pool to minimize visible scarring and landform alteration in areas to be viewed by the public upon project completion.

b. To preserve fish and wildlife habitat, the reservoir clearing plan would provide for removing as little vegetation as possible without interfering with other project purposes. Trees able to withstand some periodic inundation would be retained in the zone approximately between gross pool and the average minimum pool elevation, 516 feet msl, to give a natural appearance. Between the average minimum pool elevation and inactive pool elevation, trees with a diameter greater than 3 inches or a height of 10 feet would be removed. Below the inactive pool elevation,

vegetation would be topped to eliminate safety hazards, but otherwise would be left intact. Also, large areas of the lake will be designated as specific fishery management areas with no clearing.

c. All construction contracts would contain a section in the technical provisions devoted exclusively to environmental protection measures required of the contractor, including measures for minimizing environmental degradation by restricting landform alteration and vegetation destruction and by controlling erosion and sources of air, water and noise pollution.

d. Special measures are included in the plans and designs for all recreation areas and facilities to assure consideration of environmental quality. An environmental design theme for recreation will be designated during Master Plan studies. An architectural treatment report will be prepared on project structures, large and small, to emphasize compatibility with the natural surroundings, and to achieve cohesion of the project by incorporating recognizable features throughout, general coordination of the various project features, and identification with elements of the environment, including a central theme. On the basis of this report, further measures will be specified in plans and designs of project features to optimize aesthetics and environmental consideration.

SECTION XIII - COSTS

54. General. -

This section summarizes costs of the optimum recreation development plan, the recommended recreation development plan, and fish and wildlife enhancement and mitigation facilities.

55. Costs - optimum recreation development plan. -

The costs of lands and facilities required for the lake and the lower Yuba River optimum recreation developments are shown in the next tabulation, based on October 1976 price levels. The basic features which make up this plan are described in paragraphs 28 and 29.

As provided by Federal guidelines, all the lands required for recreation development, initial and future, would be acquired initially. By acquiring all the lands initially, the Corps can assure that these lands are available for developing the optimum recreation potential of the project in the future should non-Federal interests elect to sponsor additional recreation and fish and wildlife enhancement features during the 10-year period following completion of construction, as provided by Public Law 89-72.

First Cost - Optimum Recreation Plan

		Initial	Future
01.	Lands and Damages		
	Lands	$1,025,465	-
	Contingencies	154,535	-
	Acquisition Cost	70,000	-
	Total - Lands and Damages	$1,250,000	-
14.	Recreation Facilities		
	Facilities Around the Lake		
	Gatesville	$1,999,000	$2,438,000
	Township I	1,652,000	1,359,000
	Township II	2,447,000	2,455,000
	Bridgeport	-	467,000
	McGinn Creek	-	963,000
	Englebright Relocations	340,000	-
	Subtotal	6,438,000	7,682,000
	Contingencies, 20%±	1,287,000	1,528,000
	Total - Facilities Around the Lake	7,725,000	9,210,000
	Lower Yuba River Facilities		
	River Mouth	49,480	8,680
	Simpson Lane		107,160
	River Bend		44,160
	Hallwood	21,480	3,680
	Daguerre Point	139,040	23,640
	Gold Tailings	77,480	8,680
	Trail System	308,000	-
	Subtotal	595,480	201,000
	Contingencies, 20%±	119,520	39,000
	Total - Lower Yuba River Facilities	715,000	240,000
	Total Recreation Facilities	$8,440,000	$9,450,000
30.	Engineering and Design	$ 1,015,000	$ 1,135,000
31.	Supervision and Administration	$ 675,000	$ 755,000
	Total	$11,380,000	$11,340,000

Annual Cost - Optimum Recreation Plan

	Economic Cost 3-1/4%	Economic Cost 6-3/8%
1. Investment		
a. First Cost	$11,380,000	$11,380,000
b. Interest during construction (Less than 2 Years)	-	-
c. Gross (or net) Investment	11,380,000	11,380,000
2. Annual Cost		
a. Interest (3-1/4%) x 1c.	369,900	
(6-3/8%) x 1c.		725,500
b. Adjustment for loss of productivity of lands (0.0175 x 1,250,000)	21,900	
( )		Neg.
c. Amortization (100 yrs @ 3-1/4% or 6-3/8%)		
(0.00138 x 1c)	15,700	
(0.00014 x 1c)		1,600
d. Maintenance and Operation (1) Recreation	171,500	171,500
e. Replacement (1) Recreation	-	-
Total Annual Cost (Federal) Initial	$ 579,000	$ 898,600

56. Costs - recommended recreation development plan. -

Recreation development costs for the recommended recreation development plan at the lake (minimum facilities for public health and safety) would be Federal costs since no non-Federal sponsor is available at this time. The costs are presented in the next tabulation, based on October 1976 price levels.

The Corps would administer, operate, and maintain the recreation and fish and wildlife program at the lake along with other project features. On the lower Yuba River downstream from the afterbay, the FWS would administer the fishery enhancement program (consisting of the hatchery, spawning channel, spawning gravels and fishery habitat improvements). Yuba County would participate in development of the six recreation sites along the lower Yuba River and would operate and maintain these facilities. Corps of Engineers forces at the lake would be available to assist in certain activities on the lower Yuba River when needed, such as periodic channel maintenance and maintenance of fish and wildlife mitigation features.

As provided by Federal guidelines, all the lands required to accommodate the full recreation potential of the project would be acquired initially to insure the availability of these lands should a non-Federal entity wish to cost-share in developing additional facilities at a later date. If no agreement with a non-Federal cost-sharing sponsor has been made within 10 years after initial project operation, the Corps may utilize the lands for

other lawful purposes within its jurisdiction or dispose of them. In no case may the lands be used or made available for use for a purpose in conflict with the purposes for which the project is constructed, and preference would be given to uses which will preserve and promote the recreation and fish and wildlife enhancement potential of the project.

First Cost - Recommended Recreation Plan

		Initial	Future
01.	**Lands and Damages**		
	Lands	$1,025,465	-
	Contingencies	154,535	-
	Acquisition Cost	70,000	-
	Total - Lands and Damages	$1,250,000	-
14.	**Recreation Facilities**		
	Facilities Around the Lake		
	Road-End Development	210,000	-
	Englebright Relocation	340,000	-
	Subtotal	550,000	-
	Contingencies, 20%±	110,000	-
	Total - Facilities Around the Lake	660,000	-
	Lower Yuba River Facilities		
	River Mouth	49,480	8,680
	Simpson Lane	-	107,160
	River Bend	-	44,160
	Hallwood	21,480	8,680
	Daguerre	139,040	23,640
	Gold Tailings	77,480	8,680
	Subtotal	287,480	201,000
	Contingencies, 20%±	52,520	39,000
	Total - Lower Yuba River Facilities	340,000	240,000
	Total - Recreation Facilities	$1,000,000	$240,000
30.	Engineering and Design	$ 120,000	$ 30,000
31.	Supervision and Administration	$ 80,000	$ 20,000
	Total	$2,450,000	$290,000

Annual Cost - Recommended Recreation Plan

	Economic Cost 3-1/4%	Economic Cost 6-3/8%
1. Investment		
a. First Cost	$2,450,000	$2,450,000
b. Interest during construction (Less than 2 Years)	-	-
c. Gross (or net) Investment	$2,450,000	$2,450,000
2. Annual Cost		
a. Interest (3-1/4%) x 1c.	79,600	
(6-3/8%) x 1c.		156,200
b. Adjustment for loss of productivity of lands (0.0175 x 1,250,000)	21,900	
( )		Neg.
c. Amortization (100 yrs @ 3-1/4% or 6-3/8%) (0.00138 x 1c)	3,400	
(0.00014 x 1c)		300
d. Maintenance and Operation (1) Recreation	130,000	130,000
e. Replacement (1) Recreation	-	-
Total Annual Cost (Federal) Initial	$ 234,900	$ 286,500

57. Costs - fish and wildlife enhancement and mitigation facilities. -

The costs for the various specific actions which will be taken to enhance and mitigate the wildlife and fishery resources of the project are presented in the next tabulation, based on October 1976 price levels. These actions are discussed in Sections VII and VIII. Mitigation measures are a project responsibility, and these costs will be borne by the Federal Government. The Fish and Wildlife Service has advised that fishery enhancement measures would be a part of a separate Federal program for the conservation of fish and wildlife, and these costs also will be borne by the Federal Government.

First Cost - Enhancement and Mitigation Features

01. Lands and Damages

Lands		$ 2,946,705
Contingencies		443,295
Acquisition Costs		200,000
Total Lands and Damages	(a)	$ 3,590,000

06. Fish and Wildlife Facilities

Fish Facilities

Hatchery	8,000,000
Supplemental Spawning Channels	3,652,500
Subtotal	11,652,500
Contingencies, 20%±	2,347,500
Total - Fish Facilities	14,000,000

Wildlife Facilities

Spenceville Wildlife and Recreation Area - 1,500 A.F. of water/year, with pumphouse and distribution lines for Dumpsey Creek & Vineyard Creek	460,000
Nesting habitat for wildlife	25,000
Spenceville, vegetation improvement	100,000
Hackett Creek, habitat improvement	300,000
Turkey mitigation lands, habitat improvement	65,000
Government-owned gravel tailings, habitat improvement	150,000
Detention ponds and habitat improvement	100,000
Fish and wildlife monitoring and analysis program	50,000
Subtotal	1,250,000
Contingencies, 20%±	250,000
Total - Wildlife Facilities	1,500,000
Total Fish and Wildlife Facilities	$15,500,000

30.	Engineering and Design	$ 1,870,000
31.	Supervision and Administration	1,240,000
	Total	$22,200,000

(a) Excludes costs for Federal-owned lands to be transferred to the project, estimated market value at approximately $900,000.

Annual Cost - Enhancement and Mitigation Features

	Economic Cost 3-1/4%	Economic Cost 6-3/8%
1. Investment		
a. First Cost	22,200,000	22,200,000
b. Market value of Federal Lands to be Transferred to Project	900,000	900,000
c. Interest during construction (Less than 2 Years)	-	-
d. Gross (or net) Investment	$23,100,000	$23,100,000
2. Annual Cost		
a. Interest (3-1/4% x 1d.)	750,800	
(6-3/8% x 1d.)		1,472,600
b. Adjustment for loss of productivity of lands (0.0175 x 3,590,000)	62,800	
( )		Neg.
c. Amortization (100 yrs @ 3-1/4% or 6-3/8%)		
(0.00138 x 1d)	31,900	
(0.00014 x 1d)		3,200
d. Maintenance and Operation (1) Fish & Wildlife Fac.	748,000	748,000
e. Replacement (1) Fish & Wildlife Fac.	38,200	28,700
Total Annual Cost (Federal) Initial	$1,631,700	$2,252,500

SECTION XIV - BENEFITS

Recreation benefits are separated into two categories: (a) general recreation, and (b) specialized recreation. General recreation includes typical reservoir recreation activities: camping, picnicking, boating, hiking, bicycling, swimming, and fishing. Specialized recreation includes activities such as river rafting, salmon, and steelhead fishing, hunting, and hatchery visitation.

58. Benefit computations. -

Project benefits are a function of project use by decade, discount rate, the 100-year economic life, and recreation day values. Project recreation use by decade is presented in Section V. Two discount rates were used in computing project benefits, 3-1/4 percent and 6-3/8 percent. Recreation day values used range from $0.75 to $2.25 per day and were taken from the schedule of values published as a part of the Water Resources Council's Principles and Standards for Planning Water and Related Land Resources (38 F.R. 174, 10 September 1973). Selection of a specific value from the given range is based on a judgement evaluation of recreation resources of the project, i.e., quality, number of activities, aesthetics, competition from other similar resources, and relationship to the user population.

The value of use of existing recreation resources in the project area without the project was computed and deducted from project gross recreation benefits to determine project net recreation benefits.

59. Gross recreation benefits. -

Gross recreation benefits, including the value of use of the existing resources, for the two development plans are summarized in the following tabulation. More detailed information is presented in the tabulations at the end of this section.

Development Plan	Gross Benefits 3-1/4%	Gross Benefits 6-3/8%
Optimum Plan		
Marysville Lake	$1,156,000	$1,006,000
Lower Yuba River	$ 715,000	$ 625,000
Total	$1,871,000	$1,631,000
Recommended Plan		
Marysville Lake	$ 850,000	$ 778,000
Lower Yuba River	$ 512,000	$ 447,000
Total	$1,362,000	$1,225,000

60. Value of existing resources. -

Existing recreation resources in the project area were evaluated and their use and resulting values established for the year 1990. Values were computed for general and for specialized recreation for both the lake and the lower Yuba River. The lake area, for the purpose of this evaluation, includes the project reach from the afterbay dam upstream to,

and including, Englebright Lake. Existing resources in this area consist of fishing, hunting, rafting, nonconsumptive wildlife use, and recreation use at Englebright Lake. Recreation facilities at Englebright Lake would be relocated above gross pool with the project, and recreation use for these facilities is expected to be the same for "with" and "without" project conditions. For the lower Yuba River, existing resources from the afterbay dam downstream to the confluence of the Yuba River with the Feather River were evaluated. Existing resources in this area consist of fishing, rafting, and a limited amount of general recreation use at several access points along the river. There is only one developed access point (a parking area and access road on the left bank near Marysville recently developed by the California Wildlife Conservation Board); others are informal with little or no development (the bridge crossing at Highway 20 is an example), and most use is by trespass since public ownership of access means has not been provided. The existing resources values are summarized below. Details of their derivation are presented in the tabulations at the end of this section.

Area	Existing Resource Value
Marysville Lake	$397,000
Lower Yuba River	$ 97,000
Total	$494,000

61. Net recreation benefits. -

Net recreation benefits are gross benefits less the value of existing recreation resources, as follows.

Development Plan	Net Benefits 3-1/4%	Net Benefits 6-3/8%
Optimum Plan		
Marysville Lake	$ 759,000	$ 609,000
Lower Yuba River	618,000	528,000
Total	$1,377,000	$1,137,000
Recommended Plan		
Marysville Lake	$453,000	$381,000
Lower Yuba River	415,000	350,000
Total	$868,000	$731,000

62. Fishery enhancement benefits. -

With a hatchery and associated fish facilities (gravel management and a special spawning channel) downstream of the afterbay, it is expected that the river fishery can be enhanced by 10,000 spawning steelhead and 70,000 spawning salmon. (See paragraph 33.) In the case of steelhead, it is expected that a 10,000 increase would provide 1,000 more fish each year for catching by sport anglers on the Yuba, Feather, and Sacramento River system. Based on an estimate of 10 recreation days of use expended for each fish caught, the recreation value of the 1,000 fish increase is:

$$1{,}000 \text{ fish} \times \frac{10 \text{ rec days}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$60{,}000$$

The 70,000 salmon that would be added to the river system would produce 280,000 mature fish, and the value to the commercial fishery is:

$$147{,}000 \text{ fish} \times \frac{10 \text{ lbs}}{\text{fish caught}} \times \frac{\$2.00}{\text{lb}} = \$2{,}940{,}000;$$

the recreation value of ocean sport fishing is:

$$56{,}700 \text{ fish} \times \frac{1 \text{ rec day}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$340{,}000;$$

and the recreation value of inland sport fishing is:

$$6{,}300 \text{ fish} \times \frac{10 \text{ rec days}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$378{,}000$$

Fishery enhancement benefits are summarized in the following tabulation:

Species	Enhancement (Number of spawning fish)	Value (Benefits)
Steelhead	10,000	$ 60,000
Salmon	70,000	3,658,000
Ocean commercial		(2,940,000)
Ocean sport		(340,000)
Inland sport		(378,000)
Total		$3,718,000

Fishery enhancement costs and benefits are compared as follows:

	3-1/4%	6-3/7%
Costs	$1,260,000	$1,760,000
Benefits	3,720,000	3,720,000
Benefit/cost ratio	3.0	2.1

LAKE RECREATION BENEFITS

	Average Annual Gross Benefits	Recreation Day Values	Existing Resources Values 1/	Average Annual Net Benefits
	At 3-1/4 Percent Discount Rate			
General Recreation (Optimum Plan)	$740,000	$1.50	$225,000 2/	$515,000
General Recreation (Recommended Plan)	$434,000	$1.50	$225,000 2/	$209,000
Specialized Recreation	$416,000		$172,000 3/	$244,000
(Hatchery Use)	($382,000)	$3.00		
(Hunting Use)	($ 34,000)	$6.00		
	At 6-3/8 Percent Discount Rate			
General Recreation (Optimum Plan)	$650,000	$1.50	$225,000 2/	$425,000
General Recreation (Recommended Plan)	$422,253	$1.50	$225,000 2/	$197,000
Specialized Recreation	$356,000		$172,000 3/	$184,000
(Hatchery Use)	($325,000)	$3.00		
(Hunting Use)	($ 31,000)	$6.00		

1/ The "Existing Resources Value" comprises recreation uses that have the potential to occur in the project area without the Marysville Lake project by 1990. Much of these uses concentrate at Englebright Lake as "General Recreation: but other uses occur in the "Dry Creek" and "Narrows" areas, as hunting and fishing. The "Existing Resources Value" does not include use that may be drawn from surrounding existing projects such as Lake Collins, Lake Wildwood, and Camp Far West.

2/ The $225,000 figure is calculated assuming a general use at Englebright Lake in 1990 of 150,000 and a "Recreation Day Value" of $1.50.

3/ The $172,000 figure represents $75,000 worth of fishing use, $82,000 worth of hunting and nonconsumptive wildlife use, and $15,000 worth of rafting use. Fishing: 12,500 recreation days of fishing use, per discussion between Bob House (FWS) and Chris Flanagan (CE) 5 Jan 76, and a "Recreation Day Value" at $6.00. Wildlife: 22,700 average annual use at $3.55 "Recreation Day Value" per 1 July 1976. Notes by Jack Bernard (CE) comparing project land resources to Spenceville Wildlife and Recreation Area. Rafting: 2500 average annual use based on estimate in "Study of Alternative Opportunities for Whitewater Boating/Rafting Activities" - U.S. Army Corps of Engineers, Sacramento District, July 1976) at $6.00 "Recreation Day Value."

LOWER YUBA RIVER RECREATION BENEFITS

	Average Annual Gross Benefits	Recreation Day Values	Existing Resources Values 2/	Average Annual Net Benefits
	At 3-1/4 Percent Discount Rate			
General Recreation (Optimum Plan) 1/	$143,000	$1.50	$5,000 4/	$138,000
Specialized Recreation (Optimum Plan)	$572,000	$6.00	$92,000 3/	$480,000
(Fishing)	($286,000)		($77,000)	
(Rafting)	($286,000)		($15,000)	
General Recreation (Recommended Plan)	$102,000	$1.50	$5,000 4/	$97,000
Specialized Recreation (Recommended Plan)	$410,000	$6.00	$92,000 3/	$318,000
(Fishing)	($205,000)		($77,000)	
(Rafting)	($205,000)		($15,000)	
	At 6-3/8 Percent Discount Rate			
General Recreation (Optimum Plan) 1/	$125,000	$1.50	$5,000 4/	$120,000
Specialized Recreation (Optimum Plan)	$500,000	$6.00	$92,000 3/	$408,000
(Fishing)	($250,000)		($77,000)	
(Rafting)	($250,000)		($15,000)	
General Recreation (Recommended Plan)	$89,000	$1.50	$5,000 4/	$84,000
Specialized Recreation (Recommended Plan)	$358,000	$6.00	$92,000 3/	$266,000
(Fishing)	($179,000)		($77,000)	
(Rafting)	($179,000)		($15,000)	

1/ Optimum Plan General Recreation includes bicycling use.
2/ "Existing Resources Values" comprise recreation uses that have the potential to occur on the lower Yuba River without the project. They do not include use that will be drawn from the Feather River, the Sacramento River, and others.
3/ "Existing Resources Values" are calculated assuming specialized recreation use in 1990 at 15,400 (12,900 stream fishing per discussion on 15 Jan 76 between Chris Flanagan (CE) and Bob House (FWS); 2,500 rafting - based on 100 users per weekend day with 90% weekend use, 20% peak month use, and 9 weekend days/month. Use estimates are from "Study at Alternative Opportunities for Whitewater Boating/Rafting Activities - U.S. Army Corps of Engineers, Sacramento District, July 1976" at $6.00 "Recreation Day Value."
4/ The $5,000 figure represents an estimate of 3,000 recreation days of use on the lower Yuba River at $1.50 "Recreation Day Value."

APPENDIX D
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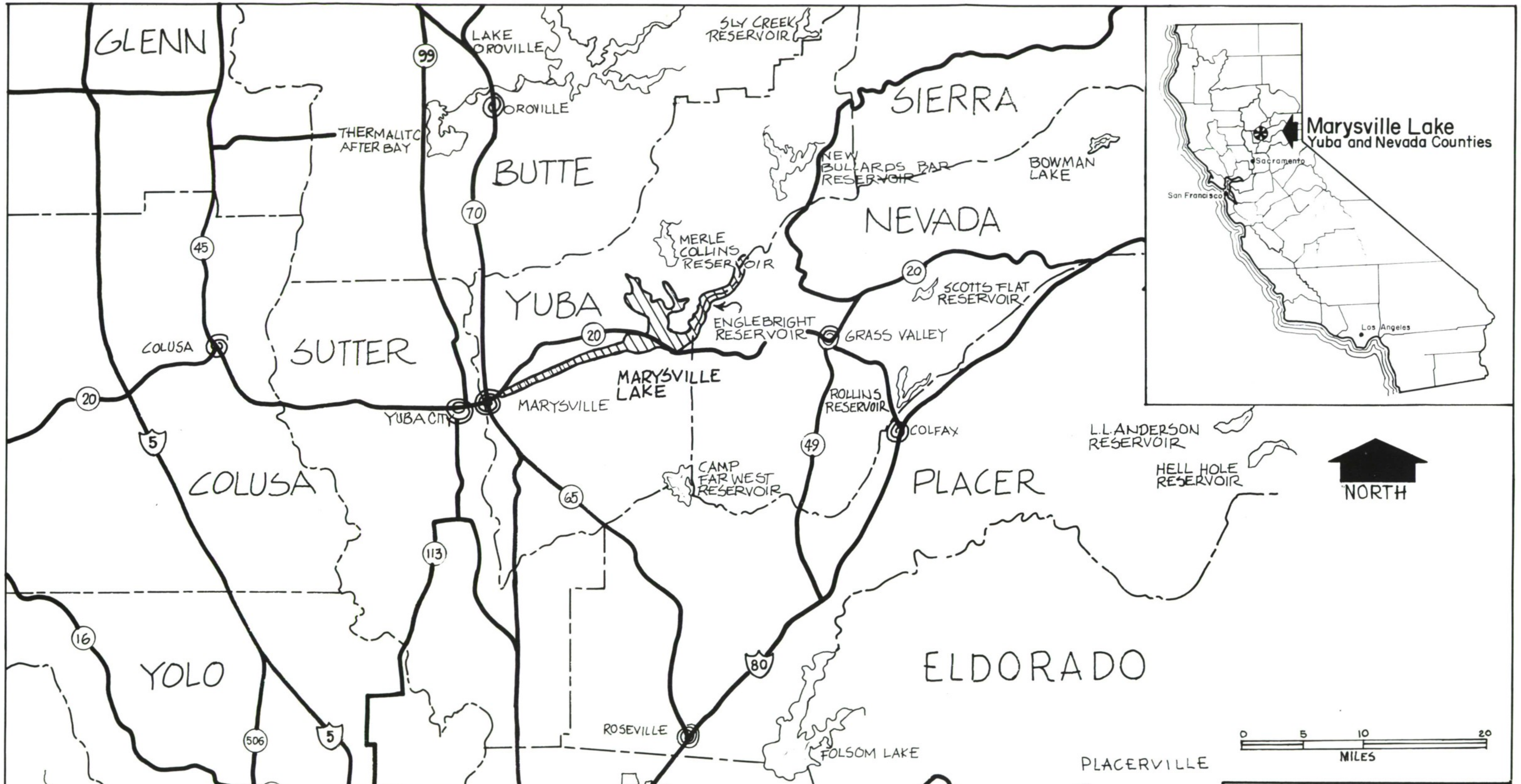
(8) U.S. Army Corps of Engineers, Sacramento District, Plan Formulation and Evaluation Studies - Recreation, Volumes I-V, IWR Research Report 74-R1, 1974.

(9) U.S. Army Corps of Engineers, Sacramento District, Sacramento River Bank Protection Project, Design Memorandum No. 2, Appendix A - Recreation Resources, 1975.

(10) U.S. Army Corps of Engineers, Waterways Experiment Station, Draft - Technical Report - Marysville Lake Hydro-Thermal Study, October 1976.

(11) U.S. Geological Survey, Surface Water Supply of the U.S., Part II Pacific Slope Basins in California, Geological Survey Water Supply Paper - 1181, 1950-1960.

(12) U.S. Geological Survey, Surface Water Supply of the U.S., Part II Pacific Slope Basins in California, Volume 4, Northern Central Valley Basins, Geological Survey Water Supply Paper - 1931, 1961-1965.



MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA

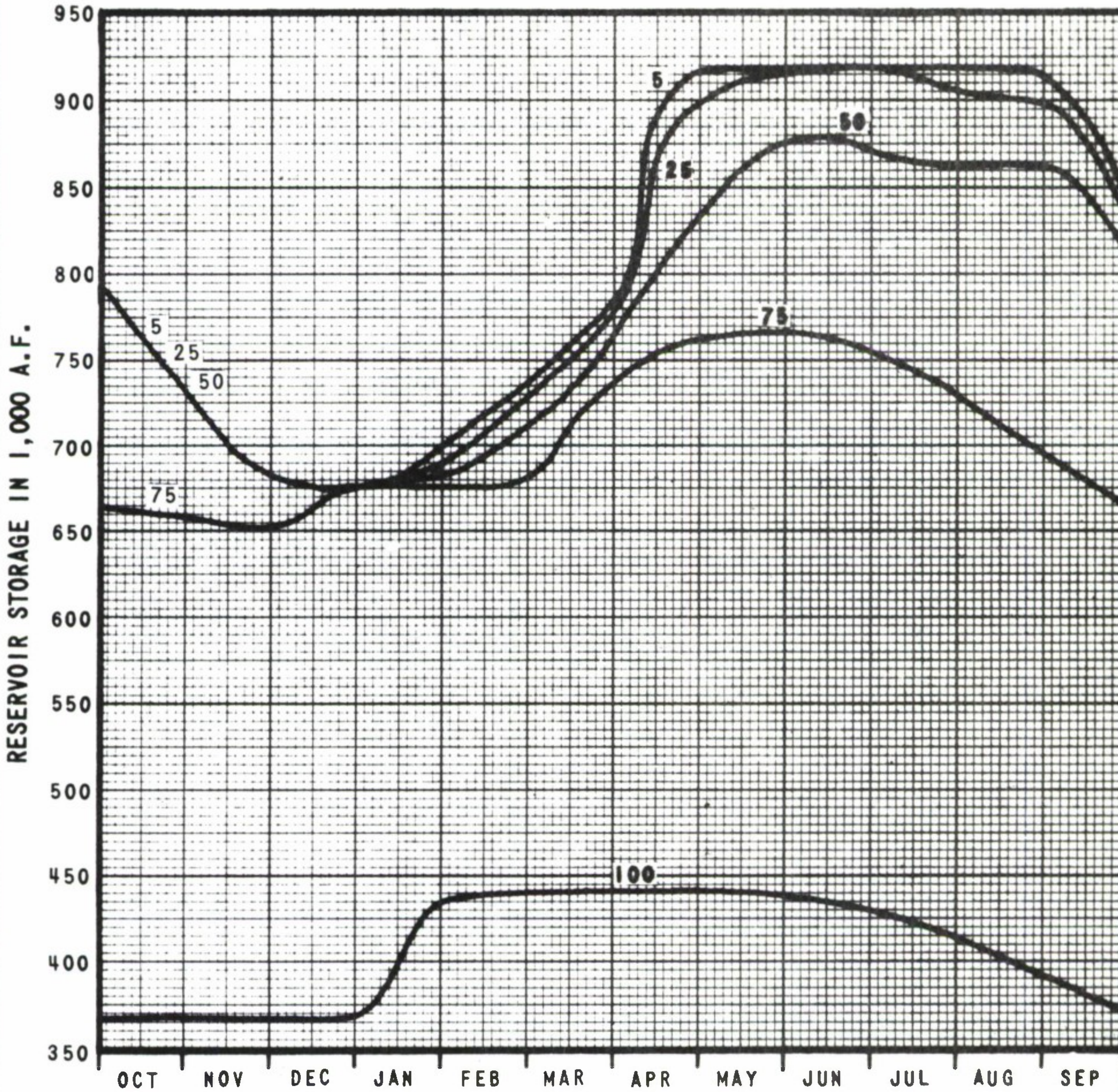
REGIONAL ACCESS AND LOCATION

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared:
Drawn: D.W.A.

Date: SEPTEMBER 1976

FIGURE D-1



NOTE:

Indicated value is percentage of years that storage is exceeded on a given date based on total end of month storage for the years 1895-1971. Data abstracted from hypothetical multiple-purpose monthly operation (U.S.B.R.), partial impairments.

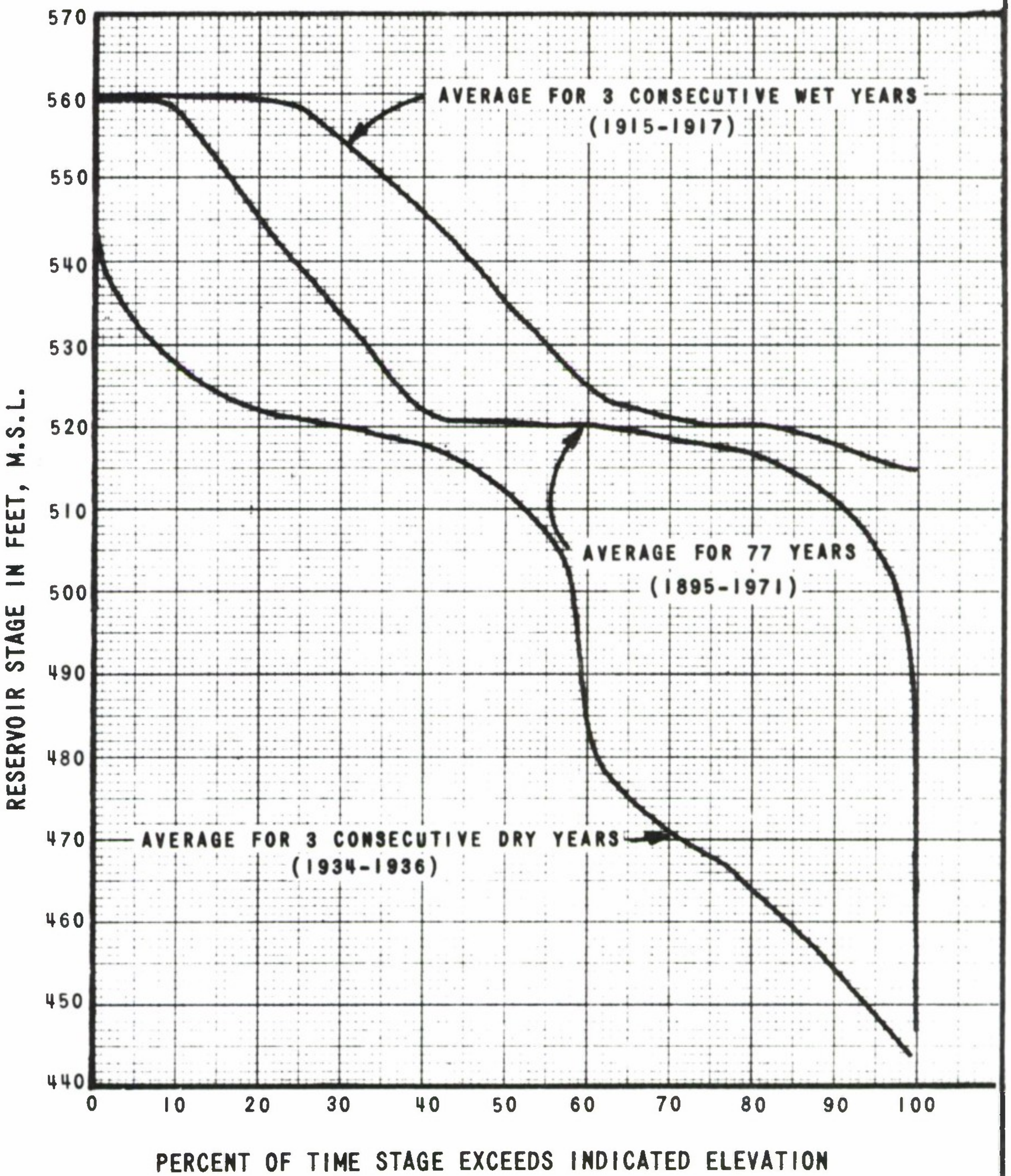
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

SEASONAL VARIATION OF
LAKE STORAGE FREQUENCY

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.O.M.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE D-2



NOTE:

Curves represent percent of time given stages are equaled or exceeded during the wettest 3 consecutive years, the driest 3 consecutive years, and the total record period, 1895-1971. Analysis based on hypothetical monthly multiple-purpose operation (U.S.B.R.), partial impairments.

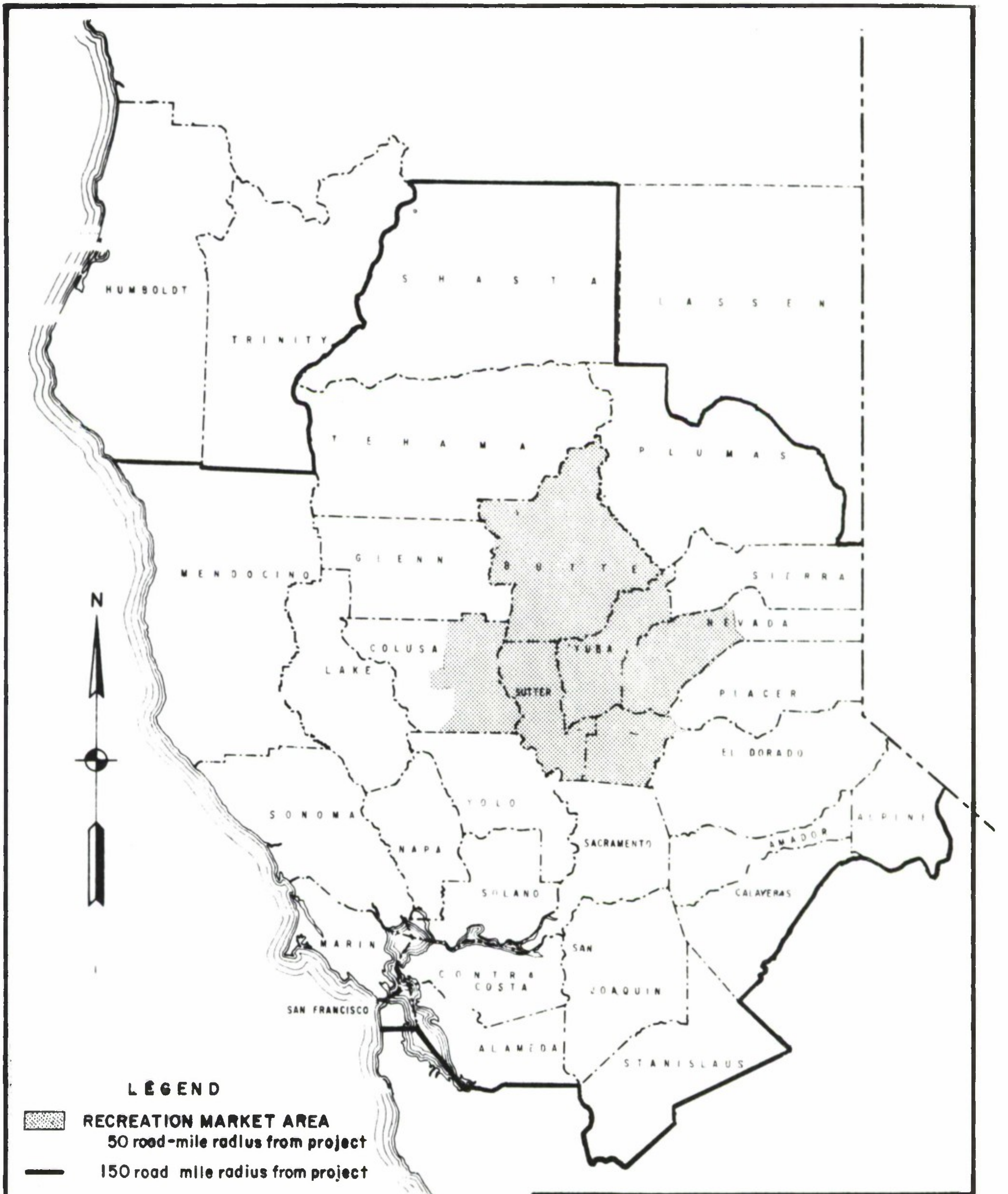
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

STAGE-DURATION CURVES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.O.M.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE D-3



Note: Consider lake & lower Yuba River as having the same Market Area.

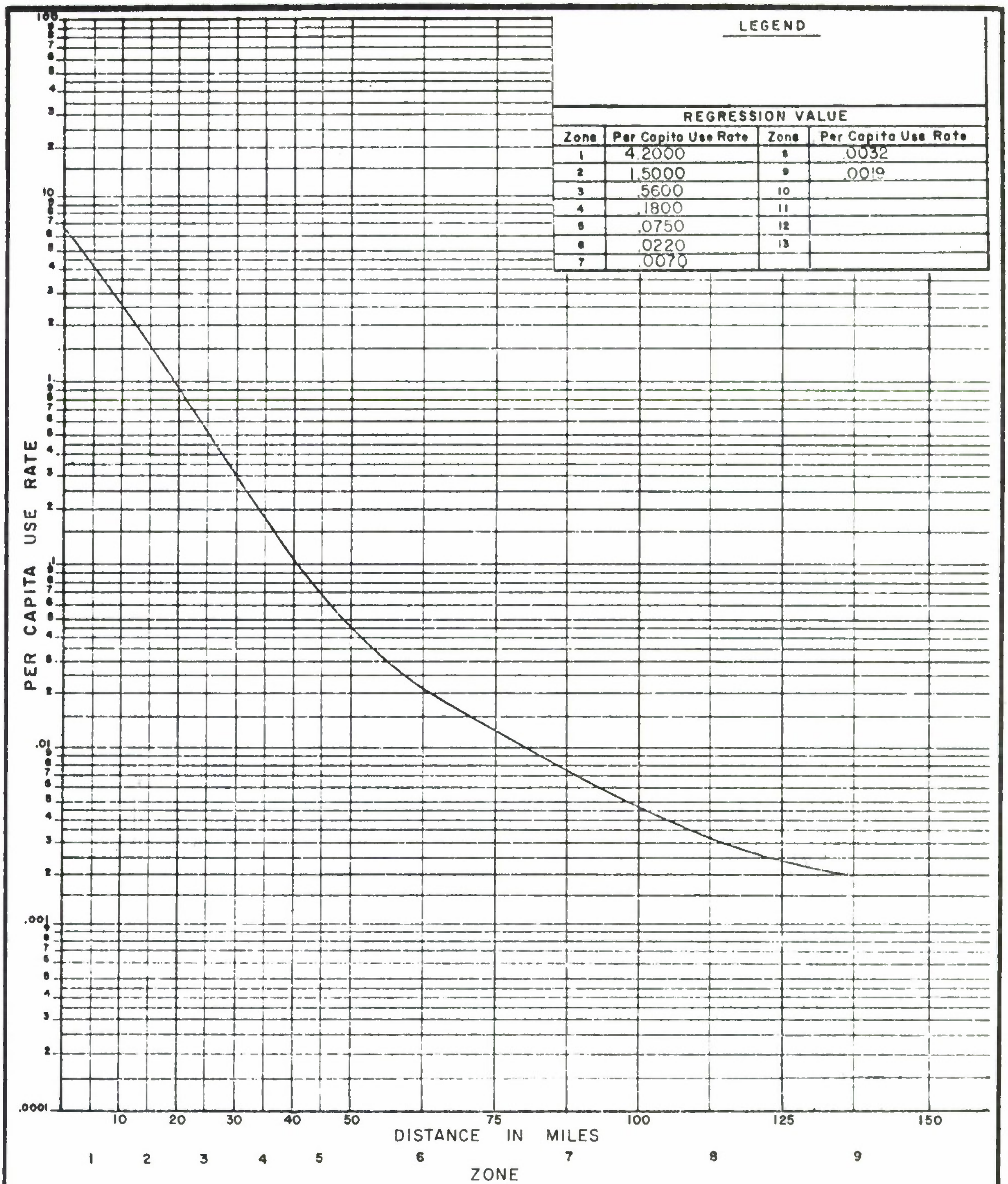
MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA

RECREATION MARKET AREA

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.M.F.
Drawn: D.W.A.
Date: JANUARY 1977

FIGURE D-4



REGRESSION VALUE

Zone	Per Capita Use Rate	Zone	Per Capita Use Rate
1	4.2000	8	.0032
2	1.5000	9	.0019
3	.5600	10	
4	.1800	11	
5	.0750	12	
6	.0220	13	
7	.0070		

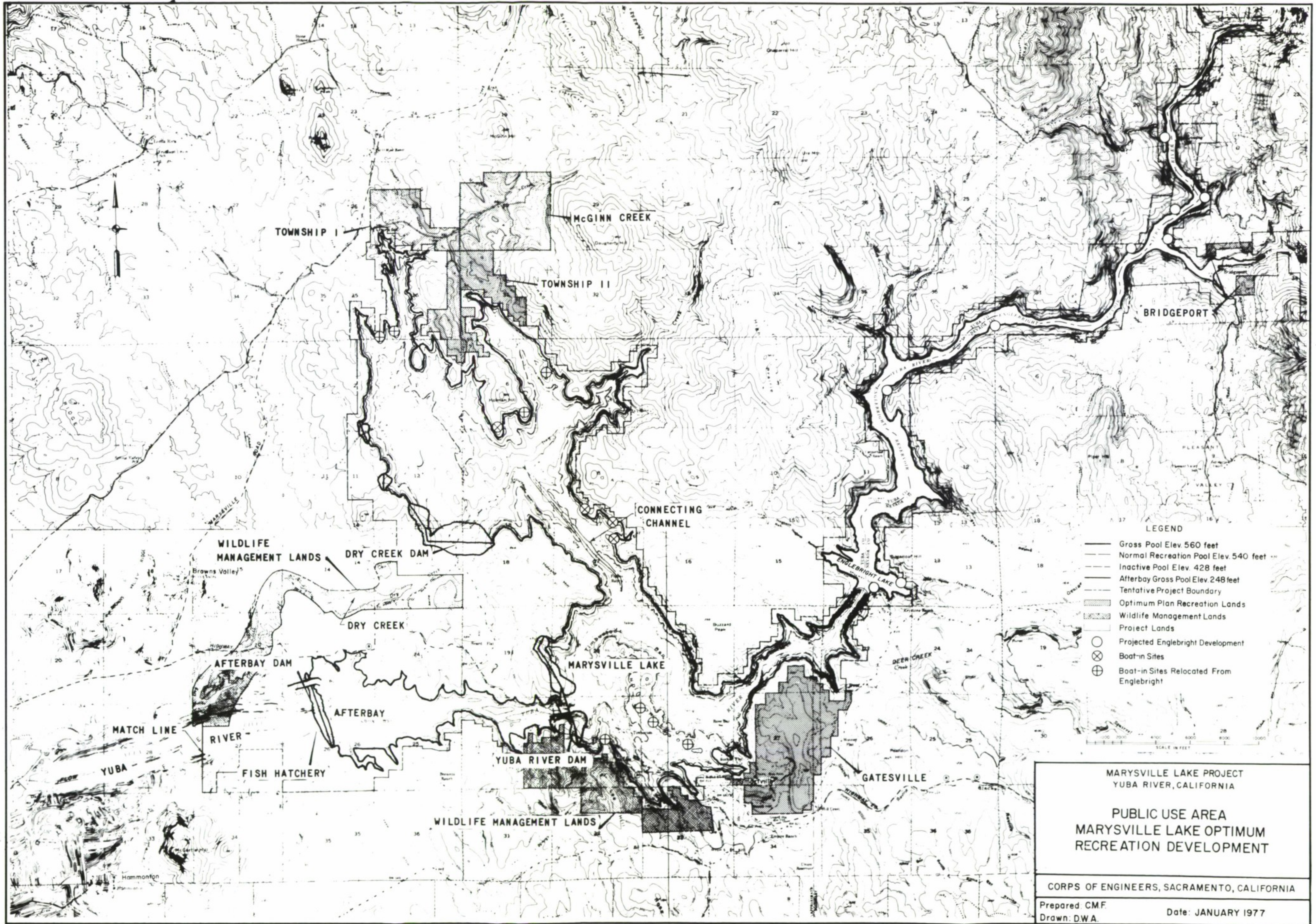
MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA

PER CAPITA USE RATE
YEAR 3

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C. F. F.
Drawn: R. G. C.
Date: JANUARY 1977

FIGURE D-5



TOWNSHIP I
McGINN CREEK
TOWNSHIP II
BRIDGEPORT
CONNECTING CHANNEL
WILDLIFE MANAGEMENT LANDS
DRY CREEK DAM
DRY CREEK
AFTERBAY DAM
AFTERBAY
MARYSVILLE LAKE
MATCH LINE
RIVER
YUBA
FISH HATCHERY
YUBA RIVER DAM
WILDLIFE MANAGEMENT LANDS
GATESVILLE
ENGLEBRIGHT LAKE
DEER CREEK
Browns Valley
Hammonton
LEGEND
Gross Pool Elev. 560 feet
Normal Recreation Pool Elev. 540 feet
Inactive Pool Elev. 428 feet
Afterbay Gross Pool Elev. 248 feet
Tentative Project Boundary
Optimum Plan Recreation Lands
Wildlife Management Lands
Project Lands
Projected Englebright Development
Boat-in Sites
Boat-in Sites Relocated From Englebright
SCALE IN FEET
MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA
PUBLIC USE AREA
MARYSVILLE LAKE OPTIMUM
RECREATION DEVELOPMENT
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: CMF
Drawn: DWA
Date: JANUARY 1977

FIGURE D-6A

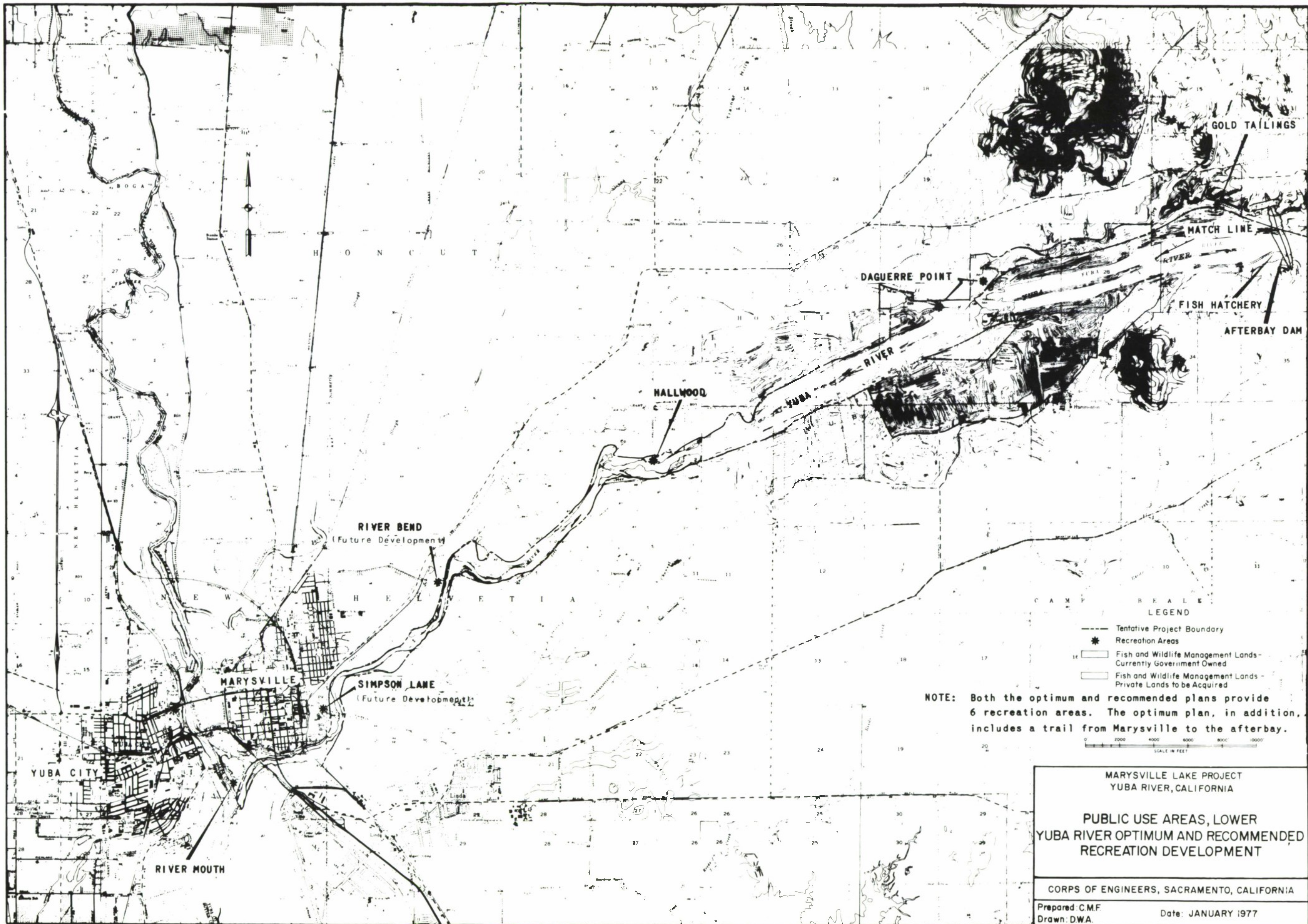

GOLD TAILINGS
MATCH LINE
Existing River Channel
DAGUERRE POINT
FISH HATCHERY
AFTERBAY DAM
YUBA RIVER
HALLWOOD
RIVER BEND
(Future Development)
SIMPSON LANE
(Future Development)
MARYSVILLE
YUBA CITY
RIVER MOUTH
HONCUT
NEW HELVETIA
CAMP BEALE
LEGEND
Tentative Project Boundary
Recreation Areas
Fish and Wildlife Management Lands - Currently Government Owned
Fish and Wildlife Management Lands - Private Lands to be Acquired
NOTE: Both the optimum and recommended plans provide 6 recreation areas. The optimum plan, in addition, includes a trail from Marysville to the afterbay.
0 2000 4000 6000 8000 10000
SCALE IN FEET
MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA
PUBLIC USE AREAS, LOWER YUBA RIVER OPTIMUM AND RECOMMENDED RECREATION DEVELOPMENT
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: C.M.F.
Drawn: D.W.A.
Date: JANUARY 1977

FIGURE D-6B

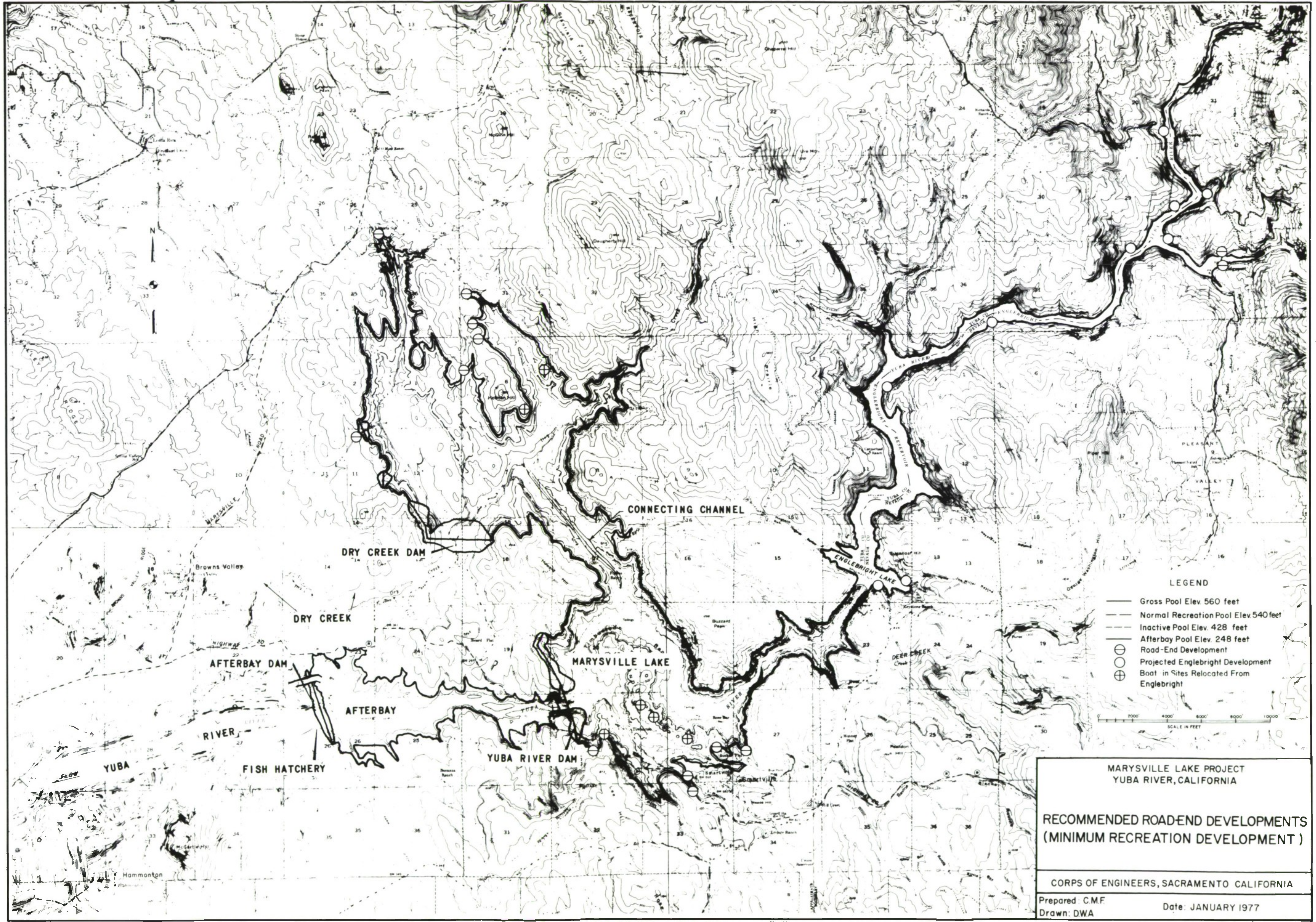
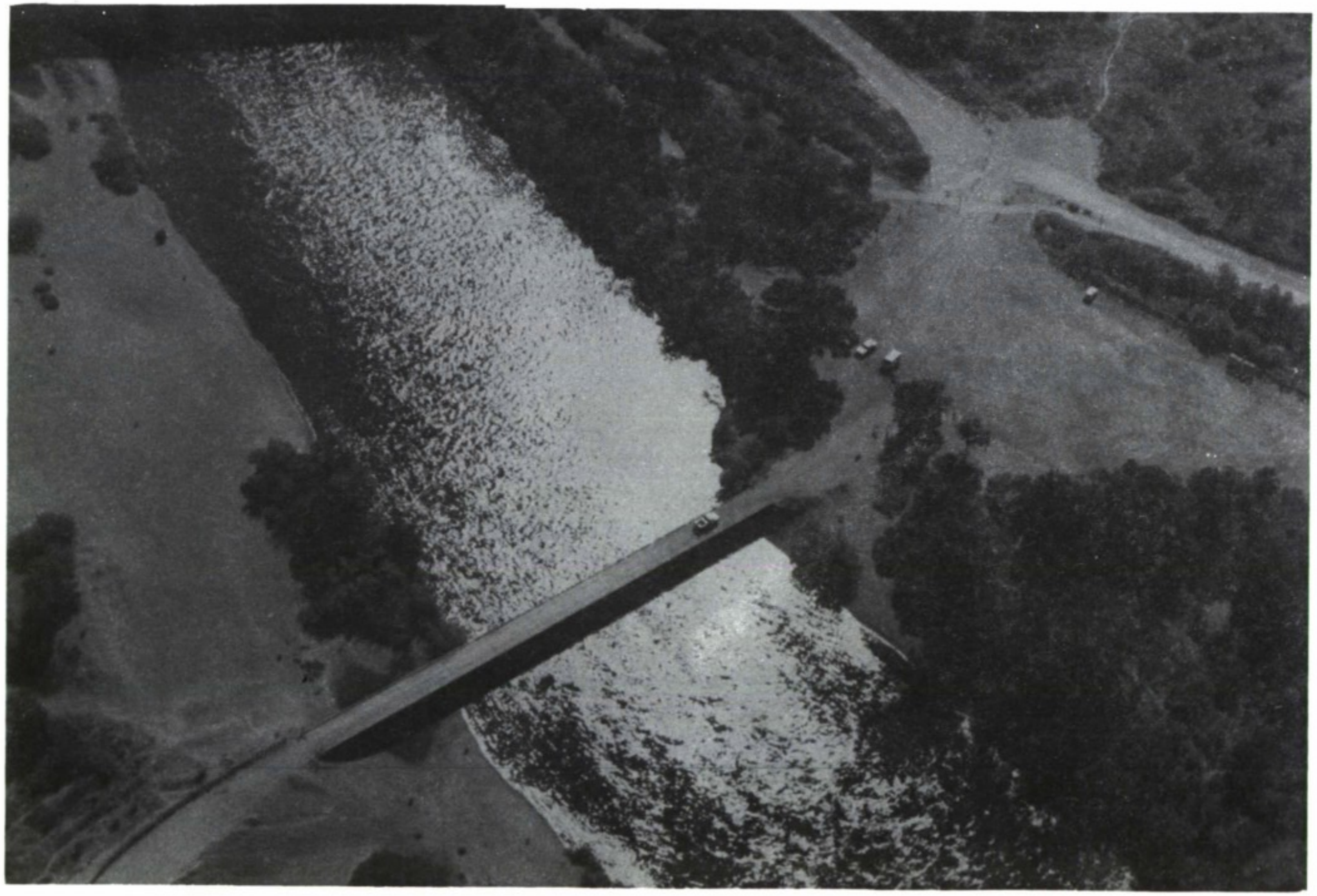
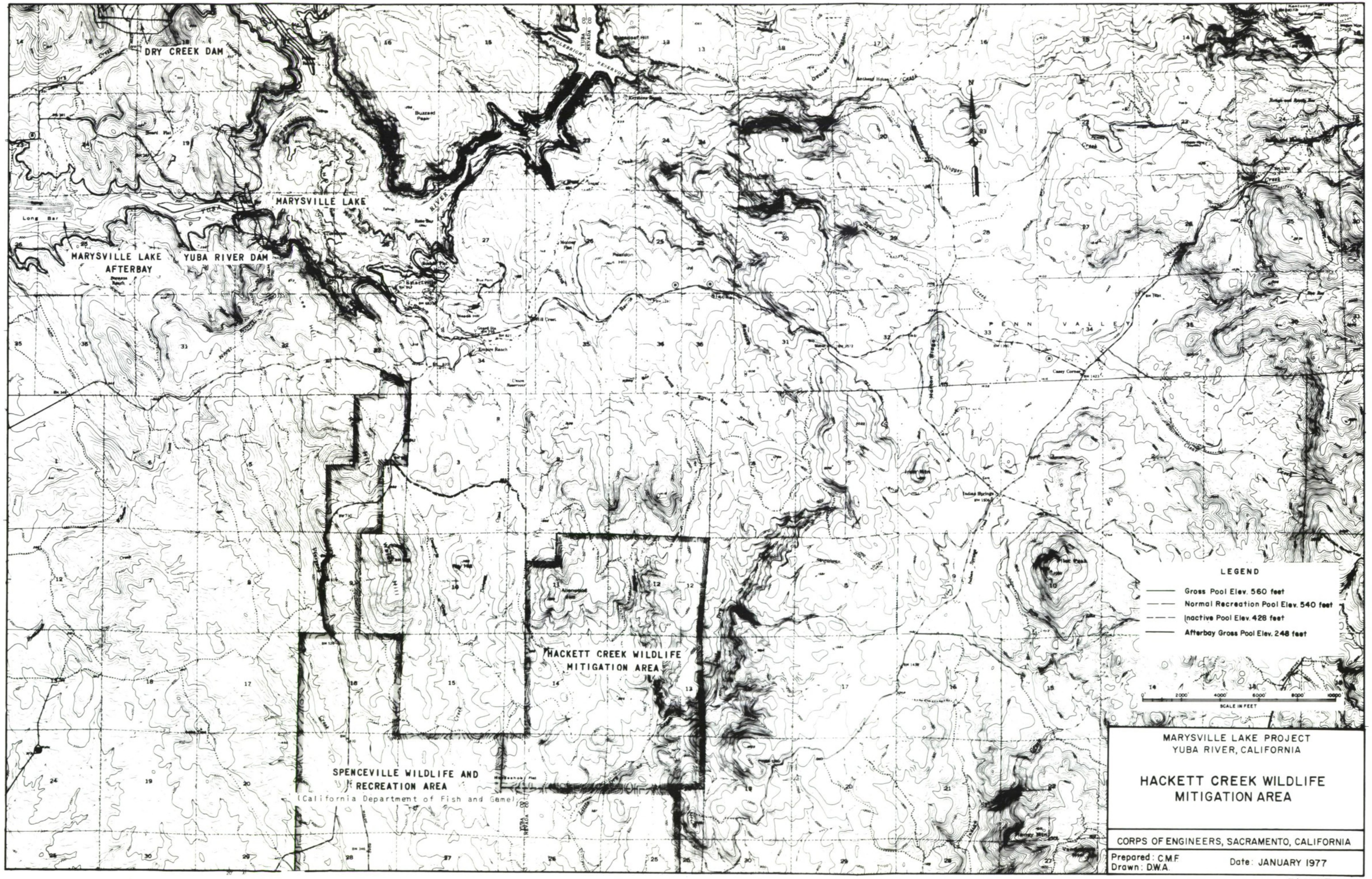

CONNECTING CHANNEL
DRY CREEK DAM
DRY CREEK
AFTERBAY DAM
AFTERBAY
RIVER
YUBA
FISH HATCHERY
YUBA RIVER DAM
MARYSVILLE LAKE
ENGLEBRIGHT LAKE
DEER CREEK
Browns Valley
Hammonton
LEGEND
Gross Pool Elev. 560 feet
Normal Recreation Pool Elev. 540 feet
Inactive Pool Elev. 428 feet
Afterbay Pool Elev. 248 feet
Road-End Development
Projected Englebright Development
Boat in Sites Relocated From Englebright
SCALE IN FEET
MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA
RECOMMENDED ROAD-END DEVELOPMENTS
(MINIMUM RECREATION DEVELOPMENT)
CORPS OF ENGINEERS, SACRAMENTO CALIFORNIA
Prepared: C.M.F.
Drawn: DWA
Date: JANUARY 1977

FIGURE D-7



Typical Lower Yuba River public access area (photo of Public Access Area on the American River west of Sunrise Boulevard Bridge).

FIGURE D-8



MARYSVILLE LAKE PROJECT
YUBA RIVER, CALIFORNIA

HACKETT CREEK WILDLIFE MITIGATION AREA

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.M.F.
Drawn: D.W.A.
Date: JANUARY 1977

FIGURE D-9

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX E - ENVIRONMENTAL SETTING

APPENDIX E - ENVIRONMENTAL SETTING

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List of Figures

APPENDIX E - ENVIRONMENTAL SETTING

1. Natural environment. -

a. Location - The Marysville Lake project site is located in the Sierra foothills of Yuba County, about 15 miles northeast of the city of Marysville, on the main stem of the Yuba River and on Dry Creek, as shown on Figure E-1. Beale Air Force Base (AFB) is about 5 miles to the south.

The Yuba River is a major tributary to the Feather River, which is a major tributary to the Sacramento River. The drainage basin of the Yuba River lies on the western slope of the Sierra Nevada and has a total area of about 1,350 square miles at the mouth and 1,296 square miles at the damsite. The mountain portion of the basin is drained by the North, Middle, and South Yuba Rivers, which flow in deep, parallel canyons. These tributaries join above the damsite to form the main stem of the Yuba River, which flows across the valley floor and enters the Feather River at the city of Marysville. The basin ranges in elevation from about 60 feet at its lower end to a maximum of 9,000 feet.

b. Topography - The watershed above the project reservoir drops from the crest of the Sierra Nevada (elevation 9,000 feet) to the low foothills at the eastern margin of the Central Valley of California. In the immediate vicinity of the eastern half of the reservoir there are

steepsided ridges as high as 2,500 feet in elevation, and the streambed is 550 feet above msl. The topography around the western half of the project is open and gently rolling; Holman Hill is the highest point at 925 feet msl and the streambed is at 200 feet msl. The flood plain downstream at the confluence of the Yuba and Feather Rivers is at about 60 feet elevation msl. Photographs of the project area are shown on Figure E-2.

Man-made features are prominent downstream of the afterbay. Dredge tailings, which occupy much of the area along the lower Yuba River, lie in symmetrical piles as high as 100 feet. Many of these tailing piles are separated from each other by a network of channels and by ponds that often have no surface inlets and outlets. Hydraulic mining during the last 125 years has contributed to the shape of the landscape near Smartville and Timbuctoo. There are several steep, bare cliffs around these two sites that are the result of such mining.

c. Geology - The Marysville project area is underlain by variably metamorphosed volcanic rocks of Mesozoic age. Minor amounts of granite, slate, and other rock types occur within the metamorphics. Except for the steeper valley sides and the floors of some of the smaller valleys, these rocks occur at the surface only in sparse outcrops. They are generally obscured by deep cover of residual soil and weathered rock or by alluvial deposits from modern and ancient streams. In some places, patches of Tertiary sediments overlie the metamorphics. A couple of

small areas of Tertiary volcanic mudflow and breccia occur near Smartville. Geology of the project area is discussed in more detail in Appendix H.

d. Seismicity - Most historical earthquakes felt in the Marysville area had epicenters more than 35 miles from the project site and occurred on the San Andreas fault system and the Sierra Nevada fault system. Prior to 1 August 1975 available data did not suggest the shear zone in the afterbay area or any other faults in the Sierra Foothill were active. However, ground cracking observed following the Oroville earthquake has been interpreted by the California Division of Mines and Geology (16) and the California Department of Water Resources as surface faulting along a fault not recognized prior to the Oroville earthquake. Prior to 1975, the quake closest to the project area with a Richter magnitude of 5.0 or greater occurred 30 miles north of Oroville in 1940 with a magnitude of 5.7; however, seismic history and mapped geology led to the conclusion that the project is located in a relatively inactive area as far as local and near-local events are concerned. The 1 August 1975 earthquake that occurred near Palermo, about 15 miles northwest of the project site, had a local magnitude determination range from 5.7. That event and the aftershocks have led to a reevaluation of the potential seismicity of the area, as discussed in Appendix H.

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

e. Soils - The project area contains six soil associations, described by Herbert and Begg (5) as:

Auburn-Sobrante-Las Posas

Redding-Corning

Sierra-Auberry

Wyman-Ryer

Englebright-Rescue

Tailings-Placer Diggings

These soil associations are described and their locations in the project area are shown in Appendix H.

f. Climate - The climate of the Yuba River basin varies widely, with marked differences in temperature and precipitation within short distances. In the mountains, winter temperatures are moderately severe, with minimums below freezing, while warm days and cool nights characterize the summer months. Frost may occur in any month at the higher elevations. The climate of the project area is typical of the California Central Valley. Summers are hot and dry; winters are generally cool and mild;

fall and spring are transitional. The following tabulation gives monthly values of the mean, mean maximum, and mean minimum temperatures for Marysville, which lies about 15 miles southwest of the project.

Monthly Temperatures for Marysville

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean (°F)	46.7	50.5	55.4	60.6	66.9	74.4	78.8	76.4	73.8	64.8	53.6	47.2
Mean Maximum (°F)	53.8	59.6	65.5	72.5	80.3	89.2	96.3	94.4	88.8	78.4	65.7	55.4
Mean Minimum (°F)	37.4	40.6	43.7	47.4	51.6	57.5	60.5	58.5	55.2	49.0	41.4	37.9

Source: U.S. Department of Commerce, Climatography of the United States, No. 86-4, 1972.

Rainfall occurs mainly during the winter months; 85 percent of the year's rain falls between October and March. Average annual rainfall is 20.59 inches at Marysville and increases with elevation to the east. The average length of the frost-free period is 280 days. (13)

g. <u>Scenic setting</u> - The Marysville Lake project, exclusive of the lower Yuba River corridor and separate wildlife mitigation lands, would encompass 19,820 acres of land, of which about 6,640 acres would be inundated by the lake at gross pool elevation 560 feet msl, including 815 acres presently inundated by Englebright Lake. The afterbay would inundate 1,080 acres at a gross pool elevation of 248 feet msl. Most of the scenery at the project site consists of rolling hills, covered with grass and open oak woodland. In the summer and fall the annual grasses on unirrigated land dry and turn a golden color, and at that time most greenery is found along the streambeds, in the irrigated pastures, and around houses. Typical site views in the project area are shown on Figure E-2.

The western part of the site has relatively gently sloping topography. Lee Hill and Howard Hill are the predominant features. In the lower parts of the site, trees and surrounding topography restrict sight distance, making the views of a local type; however, in the more rugged eastern portion of the site there are impressive views, particularly of the Yuba River Narrows and the surrounding hills. There are few easily accessible viewing points, the most common being from Englebright Dam, on the Mooney Flat Road near Deer Creek, and from Parks Bar. The river canyon and the cliffs remaining from hydraulic mining may be viewed from Rose Bar and Forbes Ranch, but these spots are much less commonly visited.

The Yuba River itself offers a variety of visual experiences, partly due to alteration of the natural setting along much of its course. The middle stretches of river in the project reach remain fairly natural, but

most of the downstream river within the project site has been altered extensively as a result of hydraulic mining and the subsequent working of dredges in the streambed. The dredge tailings along the riverbanks create a landscape of gravel mounds and pools. The Yuba Narrows between Englebright Dam and Rose Bar is a gorge with swift-flowing water and rapids. It is possible to walk into the gorge at several points. The river downstream from the Yuba Narrows to Hallwood Boulevard flows over a wide gravel bed and resembles a glacial outwash stream. The river braids in several spots and there are frequent riffles.

Dry Creek at Hammond Grove County Park between Highway 20 and the Yuba River provides visual contrast, flowing slowly through tree-shaded pools covered with floating plants.

h. Vegetation - Vegetation and land use in the project area is shown on Figure E-3. The woodland-savanna vegetation type comprises about 60 percent of the total project area and includes two distinct communities of riparian woodland and the oak-digger pine community of the foothill woodland. The remaining 40 percent of the area is predominantly agricultural and grasslands, with a small amount of chaparral occurring at high altitudes. The following tabulation shows acreages of the several plant communities for the total project study area.

Plant Community	Project Study Area (acres)
Sycamore-alder-oak riparian woodland	300
Willow-cottonwood riparian woodland	190
Riparian	1,100
Oak-digger pine woodland	11,630
Chaparral	410
Grassland-agricultural	4,070
Miscellaneous 1/	4,580
TOTAL	22,280

1/ Water surface, Englebright Lake, tailings, sandbars, urban, etc.

The foothill woodlands occur throughout the project area. The riparian woodland is strongly influenced by the occurrence of permanent standing or running water along the Yuba River, Dry Creek, and other tributaries of the Yuba River, and surrounding ponds in the tailings area. Annual precipitation is too little to support the thick growth of

deciduous trees, shrubs, and vines found along permanent watercourses. Other factors, such as soil type and streamflow pattern, influence the species composition of the riparian woodlands along the Yuba River and its tributaries. Two distinct plant communities can be seen, both of which can be classed as riparian woodland. These are a sycamore-alder-oak riparian woodland and a willow-cottonwood community. Dry Creek and the lower reaches of Sanford Creek support remnants of the once widespread sycamore-alder-oak riparian woodland. This plant community is rich in species and is restricted to the lower foothills and the valley floor.

Sycamore-Oak-Alder Riparian Woodland - The sycamore-oak-alder riparian woodland along Dry Creek is a two-storied forest with nearly complete closure and extensive shrub undergrowth. The most common tree species are sycamore (Plantanus racemosa), alder (Alnus rhombifolia), interior live oak (Quercus wislizenii), Oregon ash (Fraxinus latifolia), black walnut (Juglans hindsii), and Fremont cottonwood (Populus fremontii). Digger pine (Pinus sabiniana), more common to the drier foothill woodland, attains considerable girth in this habitat, but is not a dominant species. The evergreen California bay (Umbellaria californica) is frequent in this community, but less common than the deciduous species.

Among the shrubs or small trees of the understory, California buckeye (Aesculus californica) and willow (Salix spp.) often reach a large size. Other common shrubs are buttonbush (Cephalanthus occidentalis var. californicus), mule fat (Baccharis viminea), and redbud (Cercis

occidentalis). Large thickets of blackberry (Rubus ursinus) form mounds scattered among the trees, and grape vines (Vitus californica) climb thickly over trees and shrubs. Chapparal species extend into this community from the drier slopes on either side, but are not plentiful and are generally restricted to the margins where the ground level is higher.

The herb layer contains many of the same grasses and forbs as the grassland community. In addition, many mesophytic species are found only in this habitat. Baby blue-eyes (Nemophila pedunculata), buttercup (Ranunculus spp.), and cinquefoil (Potentilla spp.) are a few of the many herbs to be seen here.

The most extensive growth of riparian woodland in the project area is adjacent to Dry Creek pools. Here too can be found the thickest growth of marsh and aquatic plants. Smartweed (Polygonum spp.), sedges and rushes (Carex, scirpus, and other genera of the family Cyperaceae), and cattail (Typha latifolia) border the pools and some stretches of streamside where the flow is slow but plentiful. The pools support a thick growth of aquatic plants. Elodea, pondweed (Potamogeton spp.), arrowhead (Sagittaria spp.), duckweed (Lemna and Spirodela spp.), are among the most common.

Willow-Cottonwood Riparian Community - The riparian community which is found along the Yuba River and in the tailings areas is distinctly different from the sycamore-alder-oak community along Dry Creek. On the

riverbanks the fluctuating water flow and lack of deep well-watered loam contribute to the absence of many species found along Dry Creek. The tailings areas, though unaffected by water flow, also lack the rich soil which supports the abundant growth on Dry Creek.

Cottonwood and willow are thick along the higher banks which are relatively undisturbed by dredging, but they grow in a narrow elevation band rarely over 6 feet in extent. Most of the riparian growth along the river is on gravel bars which are prone to shifting and erosion by the high water of the annual spring runoff.

The riparian community which surrounds the tailings ponds is of a similar species composition to that along the river. The sand-gravel-cobble substrate of the tailings may only be capable of supporting a community of weedy and invasive species which are adapted to poor soil.

The dominant tree species of this riparian community are willow and cottonwood. Digger pine seedlings are sometimes seen on the tailings and on gravel bars, but the lack of larger trees makes it doubtful if they will remain more than a few years where the water flow and level fluctuates to any great extent. Both deciduous species range from a shrubby, low habitat, usually seen as thickets marking high water lines from previous years, to good-sized trees which have survived the floods of many seasons. Both species are capable of surviving inundation and are often seen growing in backwater areas in water up to 1-1/2 feet deep. Other shrubs

occur in this habitat but to a lesser extent than willow and cottonwood. Some of these are blue elderberry (Sambucus caerulea), river dogwood (Cornus glabrata), and blackberry. A few species of the annual grasslands are seen here, but crabgrass (Digitaria spp.), knotgrass (Paspalum spp.) and barnyard grass (Echninochloa crusgalli), are more common. Some of the more common forbs are yellow star thistle (Centaurea solstitalis), willow herb (Epilobium spp.), wormwood (Artemisia biennis), vervain (Verbena bonariensis), and, near the water's edge, smartweed, sedges, and a few herbs are seen.

Most of the gravel bars and tailings do not support enough vegetation to be considered a riparian community. However, some vegetation is becoming established on the tailings and the higher gravel bars. Clumps of willow 6 to 9 feet in height are scattered on the higher gravel bars along the main river channel. Knotgrass and brome (Bromus spp.) grow thinly on level areas. Sedges and smartweed occupy low, perenially damp ground. A few of the species of forbs noted as present on the gravel and cobbles are: horse weed (Conyza canadensis), wild lettuce (Lactuca spp.), bur-marigold (Bidens laevis), horehound (Marrubuim vulgare), and mullein (Verbascum spp.). Only two native plants, blazing star (Mentzelia laevicaulis), and a buckwheat (Eriogonum vimineum) were noted among the many pioneers of the gravel and cobble areas, though doubtless others occur there.

Oak-Digger Pine Woodland - At lower elevations the aspect of the foothill woodland is that of an open woodland or savanna. The lack of

shrubs, the scattered trees, and the low growth of grass brings to mind a carefully cultivated and pruned park. It is, however, a natural appearance of this transition zone between grassland and woodland. As the elevation increases, the trees become less scattered until, on some slopes above 650 feet, crown closure is nearly complete. For the most part, though, the foothill woodland remains relatively open, with 40 to 60 percent crown closure.

In the past, the foothill woodland covered nearly all the foothill area between the grassland and the montane forest. Much land at lower elevations has been cleared of trees and converted to pasture, cropland, or residential farmland. Thus there are extensive areas within the foothill zone which are now grasslands or agriculture lands. Some of these support small stands of woodland vegetation, usually on steeper slopes.

Where ground water seepage, permanent streams, or irrigation ditches provide a more or less constant water supply throughout the dry season, cattail, sedges and rushes, willow, and cottonwood can be seen, along with other plant species more common to the riparian communities discussed above. Representatives of these communities are often seen as single specimens or small stands along watercourses which are dry in summer and fall, but their extent rarely exceeds a fraction of an acre.

Though shrubs become more common as the trees of the woodland become more dense, a thick shrub growth under the tree overstory is rare. More

often shrubs occur in areas where trees are spaced widely, allowing adequate sunlight to reach the understory. Poison oak (Rhus diversiloba) is as likely to be found under trees as in the open, but others such as manzanita (Arctostaphylos spp.), buckbrush (Ceanothus cuneatus), coffee berry (Rhamnus californica), and oak gooseberry (Ribes quercetorum) are less shade tolerant. All these shrubs are members of the chaparral vegetation type as well as of the foothill woodland.

Oaks are the most common trees of the foothill woodland. Valley oak (Quercus lobata), with a relatively mesic habit, is more often seen on lower slopes and along watercourses where the water supply is plentiful. In the drier habitats, interior live oak (Q. wislizenii) and blue oak (Q. douglasii) predominate. Sharing dominance with the oaks is digger pine. An occasional madrone (Arbutus menziesii) can be found among the oak and digger pine, and in dry ravines California buckeye (Aesculus californica) joins this oak-digger pine community. At higher elevations, about 1,000 feet, California black oak (Quercus kelloggii) occurs, and at the extreme eastern end of the project area ponderosa pine (Pinus ponderosa) fingers down the slopes from higher elevations.

The ubiquitous grasses of the valley occur throughout the foothills. It is here, however, where many of the once common native perennial grasses find a refuge. Slopes are often steep and rocky in the foothills and this protected them from the overgrazing by livestock that marked the latter half of the 19th century and the early years of the 20th. Even now, some

areas show signs of being severely overgrazed. Dr. Rowell (7) has noted one steep, rocky area of about 1/2 acre on the north flank of Buzzard Peak where needle grass (Stipa spp.) and melic grass (Melica spp.) are to be found. Several species of perennial grasses still may be found in the foothills, and the herbarium at the U.C. Sierra Foothill Range Field Station contains some seven species of native grasses.(1) All have been located within the boundaries of the Field Station which is located partly within the Marysville Lake project study area. Three introduced species have become established in the project area. The tree of heaven (Ailanthus altissima) is found in all plant communities of the project area, but particularly in the foothill woodland. The other newcomers to the area are not so widespread. The tamarisk (Tamarix pentandra) is found occasionally along watercourses below 4,000 feet.(1) Figs (Ficus spp.) have been noted in several locations, but their spread does not seem to be as rapid. Other escaped species, shrubs and forbs as well as trees, are undoubtedly to be found within the project area.

Chaparral - Where shrubs do grow densely, they form nearly impenetrable thickets known as the chaparral community. It is a broad-sclerophyll (hard leaf) type of vegetation often filling the ravines and covering south slopes, while the oak-digger pine community grows on the ridges and on north, east, and west slopes. Within the project area, it is likely that the greatest part of the chaparral is a subclimax which is maintained by periodic fires.(1)

Valley Grassland - Very little of the project area can legitimately be classed as valley grassland. Grazing and clearing of trees to allow development of crop and pasture lands have so changed the aspect of the lower foothills and the edges of the flood plain that it is often difficult to determine what the original vegetation of any given area may have been. Following convention (1), an arbitary boundary of the valley grassland can be set at the 400-foot contour. However, patches of grasslands also occur in level valleys and on gentle slopes for some distance up into the foothills. Often there is little difference between unimproved agricultural areas which are used exclusively as pasture and adjoining grasslands since the latter has the same composition of annual grass species as the former. Grassland and agricultural areas are combined on Figure E-3, due to the similarity of species in open grassland and improved pasture.

Most of the forbs and grasses of the valley grassland extend through the foothill woodland also. Thus the following discussion of species applies generally to both vegetation types except for those specialized habitat types which are mentioned.

The perennial grasses of the Central Valley and surrounding foothills have been almost completely replaced by introduced annual grasses, most of which are of Mediterranean origin. Small fescue (Festuca microstachys), six-weeks fescue (F. octoflora) and Scribneria (Scribneria bolanderi) are

native annual grasses which still are found in the valley and foothill plant communities. Although not reported for the project area, it is likely that all three occur there since it is well within their range.

The present dominant grasses of the valley grassland and the foothill woodlands are the bromes (<u>Bromus</u> spp.), wild oats (<u>Avena</u> spp.), and fescues (<u>Festuca</u> spp.). Legumes such as clovers (<u>Trifolium</u> and <u>Medicago</u> spp.) are abundant, as are the filarees (<u>Erodium</u> spp.), most having been introduced as animal forage. Many other species were accidental introductions.

i. <u>Wildlife resources</u> - Wildlife of the project area is typical of that associated with the various habitat types found in the area: oak-digger pine woodland, grassland-agricultural, and riparian. These are some of the most productive wildlife habitat types found in California and offer both cover and abundant food for a wide variety of wildlife species. On the basis of limited field studies, (1) (10) (18) (20) habitat availability, and habitat requirements, a total of 299 vertebrate species (51 mammals, 222 birds, 18 reptiles, and 8 amphibians) may reside in the project area or visit it periodically.(1)

Mammals - Columbian black-tailed deer (<u>Odocoileus heminonus columbianus</u>) are found within the Marysville Lake project area and are common residents throughout Yuba County. Black-tailed deer reside in all habitat types, but their density varies with the type and abundance of

browse species. Riparian and oak woodland habitat types support the highest black-tailed deer densities. Grasslands and agricultural meadows support deer during periods of new grass growth but receive little use during the remainder of the year. Very low densities occur in the tailings and along sand bars where few key browse species and little cover are found. Buckbrush (Ceanothus cuneatus) is the key deer browse on the project area, and deer concentrations are highest near areas of high buckbrush cover.(1) Brushy areas in the various stages of succession support higher densities of deer than do areas of little or no understory. In general, the existing deer data for the project area are inadequate to properly assess the current numbers and status of the population.

Irregular sightings, a lack of sign, and lack of livestock depredation reports suggest that mountain lions occur in the project area only as transients or young lions which have not established home ranges. Adult lions maintain large territories of 30 to 200 square miles(1), and because of this behavior the sightings of this species are rare throughout its range.

Black bears (Ursus americanus) primarily inhabit the ponderosa pine (Pinus ponderosa) and boreal communities of the Sierra Nevada, but may occasionally visit the project area.

A total of 14 species of furbearing mammals may occur in the project area, including muskrat (Ondatra zibethica), beaver (Castor

canadensis), mink (*Mustela vison*), river otter (*Lutra canadensis*), bobcat (*Felis rufu*), and coyote (*Canis latrans*). Muskrats and beaver commonly occur in riparian habitat as well as permanent ponds. River otters and mink also reside in these habitat types, but are less abundant. The bobcat may be found in oak woodland, chaparral, and riparian habitat types. Coyotes are common residents of most habitat types in the project area. No data were available on livestock depredation by coyotes in the project area, but they can be assumed to occur infrequently. The rocky, brushy slopes of the foothills provide excellent habitat for ringtails (*Bassariscus astutus*). Although this dry habitat is preferred, ringtails will not live in an area without a permanent water supply. Ringtail densities of up to six individuals per square mile exist in California. Data from the Sierra Foothill Range Field Station also indicate particularly high population densities occur on the station.(1)

Waterfowl - The species list of waterfowl that may frequent the project area (1) includes all species found in the Sacramento Valley; however, waterfowl habitat found within the project area is of marginal quality. Existing wetlands are man-made or significantly altered from their original state. Duckel's 5-acre pond and the lower portion of Dry Creek are areas that provide necessary waterfowl habitat requirements, but these areas comprise a very small portion of the existing wetlands in the project area. The gravel ponds and dredge ponds are cold, deep, and steep-sided

and lack both food and shoreline loafing area. Little emergent vegetation exists, and shoreline cover is very sparse on many of the ponds. The gravel banks of Yuba River support little of the vegetation and aquatic life needed by waterfowl. Quiet backwaters and sloughs with emergent vegetation are not present. The project area offers some waterfowl resting areas on ponds and riverbanks, but feed and adequate nesting habitats do not exist in sufficient amounts to attract high or medium levels of resident or migratory waterfowl.

The overall production of waterfowl within the project area is not significant. The majority of ponds and water courses in the area offer only marginal nesting and habitat sites of the sort that are necessary to ensure good production and survival by nesting waterfowl. Mallards and wood ducks are the most common nesting waterfowl within the project area. The wood duck prefers quiet waterways and ponds, as does the adaptable mallard.(1) Nesting of both species occurs along Dry Creek and in the dredge and farm ponds of the area. Some nesting by the cinnamon teal occurs. Nesting by other species in the area is not documented in the literature but probably occurs to a minor degree.

Winter use of the project area by waterfowl is low except at Duckel's pond. Counts of 500 geese and 2000 ducks per day have been recorded during the fall and winter months on the pond.(1) The common dabbling ducks (Mallard, Pintail, Teal, Wigeon), geese (Canada, White-fronted, Snow) and diving ducks (Bufflehead, Ruddy Ducks, Golden

Eyes) are found on this pond. No other concentrations of waterfowl appear to be present in the project area.

Upland Game - The most important upland game species in the project area is the wild turkey (Meleagris gallopavo). They were first introduced into California in 1887. During 1967, 1969 and 1970, the California Fish and Game Department introduced 34 Rio Grande turkeys from Texas into the Spenceville Wildlife and Recreation Area adjacent to the project area.(1) Some of these birds moved north into the project area and have become successfully established there. They have developed into two flocks, one near Dry Creek and another south of the Yuba River in the vicinity of Smartville. The population of both flocks has grown to an estimated 200 birds in 1974.

California or valley quail (Lophortyx californicus) is the most abundant upland game species in the project area. Studies by the U.S. Fish and Wildlife Service in 1974 and 1975 indicate these birds are found primarily in the riparian habitat along Dry Creek, the Yuba River, and to a lesser extent in the adjacent oak woodland.

Ring-necked pheasants (Phasianus colchicus) occur in small numbers in the project area. The limited crop production in the project area has not allowed the development of a substantial population.

The mourning dove (Zenaida macroura) band-tailed pigeon (Columba fasciata), western gray squirrel (Sciurus griseus), black-tailed jack

rabbit (Lepus californicus), desert cottontail (Syvilagus audubonii) and brush rabbit (Syvilagus bachmani) all occur in the project area. The mourning dove is a permanent resident of the area, nesting from late April to August. Band-tailed pigeons are found in small numbers in oak-woodland habitat since acorns are a major food source. Western gray squirrels and the three species of rabbit are common residents of oak-woodland and other brushy habitat in the project area.

Non-Game Birds - A wide diversity of bird species occurs in the project area. On the basis of habitat occurrence, a total of 92 year-round residents, 32 spring and fall migrants, 46 summer visitors (all potentially breeding in the area), and 52 wintering bird species may occur in the study area. Birds of prey sighted in the area include the golden eagle, the marsh hawk, and the sharp-shinned hawk. The acorn woodpecker, common flicker, lark sparrow, common crow, western bluebird, scrub jay, house wren, and Anna's hummingbird are commonly observed in the oak woodland areas. Typical spring and summer visitors to the area include the tree swallow, phainopepla, Wilson's warbler, Northern oriole, nighthawk, caspian tern, and western flycatcher. Riparian habitat is the highest in bird species diversity and density, followed by oak-woodland.

Non-Game Mammals - Twenty-nine species of non-game mammals may occur in the Marysville Lake project area, with 18 species having been recorded by the Sierra Foothill Range Field Station. The oak-woodland habitat supports the greatest variety, with 23 species represented, including 13 species of bats.

Reptiles and Amphibians - Eighteen species of reptiles and 8 amphibians may occur in the project area.(1) The species reflect the relatively dry nature of the area by the large number of snakes and lizards listed in relation to the limited number of amphibian species. Aquatic species represented occur primarily around tailings ponds or near the rivers and streams of the area. Few data are available concerning the status of the various species, but a substantial population of western rattlesnake (Crotalis viridis) is known to occur in the project area.(1)

There are no known rare or endangered mammals, amphibians, or reptiles in the project area. Except for a pair of Southern bald eagles (Haliaeetus Leucocephalus) observed along the Yuba River in the spring of 1976, no rare or endangered species of bird has been recorded in the project area; however, the potential exists for occasional use by the peregrine falcon (Falco peregrinus anatum), and the rare California yellow-billed cuckoo (Coccyzos americanus occidentalis), a species classified as endangered by the State of California.

j. Fishery resources -

Anadromous Fisheries - Four major anadromous fishes are present in the Yuba River: king salmon (Oncorhynchus tshawytscha), steelhead (Salmo gairdneri), American shad (Alosa sapidissima) and striped bass

(*Morone saxatilis*). Natural variation in conditions in the Yuba River and various impacts of man on the aquatic habitat have resulted in constantly changing population densities for these species. The Yuba River appears to have an abundance of suitable spawning substrate. The limiting factors for utilization of this substrate for spawning are water depth and velocity, which in turn are dependent upon discharge.

King, or chinook salmon, are the largest and most important commercial anadromous fish in the Yuba River. Because of their size (often exceeding 30 lbs.) and food quality, they are highly prized by both commercial and sport fishermen. Most sport catches of king salmon in California are taken by trolling outside Golden Gate Bridge, but some fish are taken within San Francisco Bay. Angling also occurs in the Sacramento-San Joaquin River Delta and farther inland. The economic value of the salmon sport fishery in the Central Valley in 1953 was estimated at $7 million.(1) The estimated value of each sport-caught salmon was $17.(1) More recent data are not available. Analysis of the anadromous fishery of the Sacramento and San Joaquin River systems through the 1950's indicates an overall decline in the commercial catch of king salmon since 1915, despite increased fishing effort.(1) The Sacramento River system, including the Yuba River, has historically been an important spawning area for this species. Annual contributions of the Yuba River to the Sacramento River salmon fishery have been extremely variable, with the average annual escapement contributed by the Yuba River to the Sacramento system from 1959-1963 estimated at 6.7 percent.(1)

The fall run of king salmon has historically accounted for more than 80 percent of the yearly escapement into the Sacramento system. In the Yuba River, fall-run fish spawn from late October through January. A small spring run occurred in the Yuba River but had virtually disappeared by 1959, presumably due to diversion and hydroelectric developments on the river. Peak downstream movement of juveniles in the Yuba River is in March and April. Downstream migration of fingerling or pre-smolt juveniles occurs from March through June. The young salmon enter the ocean in June where they remain until their 4th year when they return to their home stream to spawn.(1)

Temperature has been of historical importance to the success of year classes of king salmon in the Yuba River.(1) New Bullards Bar Dam was completed in 1969, with 1970 being its first full year of operation. Special facilities installed at the dam have enabled the Yuba County Water Agency to exercise a certain amount of control over downstream water temperatures in the Yuba River. Before 1970, high temperatures in the summer months, July through early October, were frequently between 68°F and 80.6°F. Temperatures before fry emergence in March and April were generally below 54.5°F. Since 1970, summer temperatures have generally been held below 66.2°F and spring temperatures below 55°F. The king salmon population in the Yuba River is in the process of reaching an equilibrium in response to new, more stable environmental conditions resulting from the completion of New Bullards Bar Dam.

Very little is known about the current status of the Yuba River steelhead population or its relative contribution to the steelhead population in the Sacramento system. The California Department of Fish and Game (DFG) estimated the 1970 run to be about 200 fish.(1) The DFG began planting steelhead smolts and fingerlings in 1971 in an effort to enhance the Yuba steelhead fishery and estimated the 1975 run at 2,000 to 3,000 fish.

American Shad - Studies conducted in the Yuba River in 1963 indicated that American shad spawned from May to mid-July.(10) Adults first entered the river when minimum-maximum daily water temperatures were 50°F and 57°F. Spawning began when water temperatures exceeded 52°F, and eggs were collected as late as mid-July. Maximum water temperature during this time was 73°F. Most shad were observed from the mouth of the Yuba River to Daguerre Point Dam. Few shad pass through the fishway at Daguerre Point Dam, although several hundred individuals were observed about 10 miles farther upstream near Parks Bar in 1969.(10) The spawning grounds are generally located in shallow areas near the head of riffles where the eggs are deposited in surface waters. Cold water releases at New Bullards Bar Dam from 1969 to date may have caused reductions in the shad run in the Yuba River.

Striped Bass - The striped bass (*Morone saxatilis*) was introduced into California waters in 1879. Striped bass occur in the Yuba River; however, they are restricted to the area below Daguerre Point Dam as

they do not utilize the fish passage devices. Juveniles and mature fish are caught incidentally by sports fishermen in the river. They are also reported to utilize the dredger ponds and channels and may spawn in these areas.

Resident Fishes - A number of resident fishes occur in the Yuba River (1), and many of these resident river species also probably occur in tributaries. Populations of cold water fishes in the Yuba River, such as rainbow trout, appear to be increasing while the abundance of warm water fishes, such as largemouth bass, smallmouth bass, and other centrarchids is declining. This transition has been associated with upstream cold water releases from New Bullards Bar Dam.

Numbers of cold water fish in Englebright Lake have also increased. In 1959, no cold water species were found in either gill net or sport catches. However, in 1973, after the completion of New Bullards Bar Dam, cold water species (kokanee salmon, rainbow trout) comprised approximately 25 percent of the gill net catch and 30 percent of the observed sport catch. Smallmouth bass and white crappie were the dominant warm water fishes collected in 1973 while large mouth bass and white crappie were less abundant.

Rainbow trout occur farther north in the Middle Yuba River and its tributaries, and rainbow trout and possibly smallmouth bass may occur in Deer Creek and the South Yuba River.

Today, Englebright Lake provides only a fair fishery. Possible reasons for this include the cold, deep waters, limited shoal areas, and low concentrations of dissolved solids. Plankton production also appears to be low, possibly associated with accelerated water exchange rates resulting from upstream releases at New Bullards Bar Dam.(1)

Ponds located among the dredge tailings left after earlier gold mining operations contain moderate to high densities of largemouth bass, bluegill, crappie and catfish.

k. Cultural resources - Cultural resources reconnaissances and surveys of the project area conducted for the Corps of Engineers located and recorded 615 sites, including 415 of prehistoric and 197 of historic origin. Prior to these surveys only one site had been known by the Cultural Resources Section of the California Department of Parks and Recreation.

The prehistoric sites located in recent surveys include 7 rockshelters, 6 lithic scatters, 44 open villages or campsites with midden, 62 extensive middens with associated bedrock mortars, 10 open sites with slight midden deposits, and 289 sites with bedrock mortars only. A major complex of prehistoric sites occurs on Dry Creek and represents a culture which began several thousand years ago. The archaeological sites in the project area are important because so little basic research has been conducted in the area and because the Yuba is one of the last major rivers of the Sierra's western slope whose foothill zone remains undisturbed.

The survey of cultural resources in the project area and vicinity located many historic sites, including 19 cemeteries, 5 early electrical production locations, 8 early road systems, 94 ranches, 24 water works (dams, reservoirs, and ditch systems), and 47 sites which relate to mining activities (20 structures and 27 actual mining operation sites). A large clustering of historic remains occurs along the Yuba River and includes the dredge tailings, Sicard Flat, Parks Bar, Rose Bar, Sucker Flat, Timbuctoo, Smartville, and the area between Sucker Flat and Englebright Lake.

Three of the historic sites, Timbuctoo, Smartville, and the covered bridge at Bridgeport, are listed on the Roster of California Landmarks. The covered bridge at Bridgeport is also listed on the National Register of Historic Places and is one of the most significant historical features in the project area. The bridge was built in 1862. It is one of the oldest covered spans in the west and is the longest single span, wooden covered bridge in the United States. It was in continuous use until 1972 when a new highway bridge in the area was completed. At that time the covered bridge was renovated by local people, and it is maintained as an historical feature of interest.

1. Recreation resources - The project area has recreation potential by virtue of its proximity to urban centers and its natural setting. Fishing, hunting for upland game species, canoeing, tubing, gold prospecting, swimming, and camping are common recreational activities in the area.

Existing recreation uses and developments in the project area are limited because of extensive private land ownership which limits public access to the river at Parks Bar, Dry Creek, Deer Creek and Rose Bar. In June 1972, Yuba Goldfields Inc. opened limited commercial access to its private holdings for public use. Gold panning, fishing, swimming, and hiking are the principal activities on this private development. The most popular point of access to the lower river is Hallwood Boulevard. Englebright Lake provides many recreational opportunities, including swimming, fishing, picnicking, skiing, and boating. In the period 1964 to 1974 the average annual visitation was 110,100 visitor days, with boating accounting for more than half of this use.

Fishing is the most popular recreational activity in the lower Yuba River. In 1967, a total of 19,400 angler days were registered along the Yuba from its mouth to Englebright Dam. The migrations of shad, steelhead, and salmon attract fishermen statewide. There is also a substantial resident population of trout, smallmouth bass, squawfish, catfish, and green sunfish. Continuing decreases in shad and warm water fish might cause an offsetting decline in associated recreation uses. The dredge ponds are used for fishing year-round by some local residents.

There are numerous game species in the foothill area, as discussed previously; however, lack of public access to private lands limits most hunting to land immediately along the Yuba River. There are three private hunting clubs in the area. The University of California Sierra

Foothill Range Field Station, which now opens its land to deer and small game hunting in season, plans to increase the range of hunting opportunities it offers.

During the past several years, the popularity of such whitewater sports as canoeing, kayaking, rafting, and tubing has increased on the Yuba River, but reliable seasonal counts are not available. The Yuba River between Rose Bar and Daguerre Point Dam is considered one of the best beginners' canoeing and tubing runs in California with easy rapids.(8) Boating at Daguerre Point Dam is dangerous, and a safety program to warn boaters of the hazardous water conditions below the dam was instituted by the Corps of Engineers and Yuba County. A concessionaire is currently renting canoes for use between Parks Bar and Yuba City. Ground Chuck Rapids, in the Yuba Narrows above Rose Bar, is a 2-1/2-mile stretch of good Class III (difficult) rapids for more advanced boaters. Swimming has been popular in the vicinity of the Parks Bar Bridge and as far as a mile upstream and downstream from the bridge.

Except for limited camping facilities at Englebright Lake, there are no Federal, State, or county camping facilities within the project area. There are campgrounds near Parks Bar and Long Bar and at Yuba Goldfields (near Hammonton). There is a limited amount of off-road vehicle use on the gravel bars in the vicinity of Parks Bar. Gold-panning activities have been increasing along the riverbanks.

Another recreational site in the project area is Hammond Grove County Park, a 12-acre park; and Timbuctoo, the cliffs above Rose Bar exposed by hydraulic mining in the 19th century, and the covered bridge at Bridgeport are sites of historical interest.

m. Air quality - The project area is in the Sacramento Valley Air Basin which consists of the counties of Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Sacramento, Sierra, Sutter, Tehama, Yolo, Yuba, all of Shasta County except the northeast corner, and the eastern portion of Solano County. The following tabulation indicates the average rates of emissions of contaminants into the atmosphere of Yuba and Sutter Counties and the Sacramento Valley Air Basin during 1970 in tons per day.

	Organic gases					
	Highly reactive	Total	Particulate matter	Nitrogen oxides	Sulfur dioxide	Carbon monoxide
Sutter County	10.6	33.5	9.4	7.3	0.9	85.0
Yuba County	10.3	23.0	8.2	7.5	0.8	73.3
Sacramento Valley Air Basin	277	573	172	213	17.9	2,090

The major air pollution problems in the Sacramento Valley Air Basin are the high concentrations of oxidant and suspended particulate matter.

Both pollutants for the valley frequently exceed the air quality standards. According to data obtained from the air quality monitoring station at Yuba City for the period 1971-1972, that area had the highest oxidant level of the four stations in the basin. This is probably due to the area not receiving the benefit of San Francisco Bay marine air flow. For the same period, measurements for suspended particulate matter exceeded the California standard on 10 occasions. Much of this matter comes from the soil, agricultural burning, and forest fires. For the entire basin, concentrations of carbon monoxide and hydrocarbons have declined, and oxidant concentrations have remained essentially constant.(9)

n. Water quality - The U.S. Geological Survey (USGS) maintains five stream-gaging stations near the project.(19)

1. Yuba River (below Englebright Dam) near Smartville

2. Deer Creek near Smartville

3. Dry Creek near Browns Valley

4. New Colgate Powerplant near French Canal

5. North Yuba River below New Bullards Bar Dam

Water quality measurements near the project site have been taken by the USGS and the California Department of Water Resources. These data

are not comprehensive, but are records of intermittent samplings that give some indication of the past and present quality of Yuba River water. Water temperatures were recorded continuously near the Marysville gaging station from October 1963 to September 1970 and intermittently from October 1970 to date. Miscellaneous chemical analyses have also been made at this site since 1953.

Water quality data for the Yuba River at Marysville, based on monthly sampling averaged for the 1966 through 1970 period, show Yuba River water to have low salinity and low boron concentrations, fairly low amounts of dissolved nutrients (nitrogen and phosphorus) that typically cause eutrophication, and high concentrations of dissolved oxygen. These characteristics all indicate good water quality.

The water quality of the Yuba during low flow periods has improved since the completion of New Bullards Bar Dam in 1970. The flow throughout the year is more constant, and the water is clearer and colder, with a lower mineral content.(12)

The quality of water in a stream such as the Yuba depends primarily on the amount of flow and the level of pollutants introduced into the water. The possible sources of pollution along the Yuba are municipal or industrial wastes (mining and lumber mills), erosion, and irrigation return flows. An earlier evaluation of mining and lumber operations showed that pollutants from these sources are not significant or are controlled

to the extent that they do not present any potential for lowering the quality of the river water.(15) This conclusion was partially based on the assumption that there are few remaining working mines in the area. Renewal of mining activity or substantial increases in logging activity could alter this situation.

Irrigation return flow enters the Yuba River from Dry Creek and constitutes a good proportion of the water in the creek during the summer. Irrigation returns often contain high amounts of fertilizers, inorganic salts, and pesticides. The dense algal blooms often observed in Dry Creek in summer probably result from the nutrients in the return flow.

Quarries have operated in the lower Yuba River from time to time, and disturbed fines from such operations could be washed into the river by autumn and winter rains.

Ground water supplies in the project area are of good quality, with a few localized areas showing a relatively high mineral content. Ground water levels, which had previously been decreasing, have stabilized as a result of a decreasing trend in agricultural land development.(6)

Enforcement and implementation of current water-quality standards, and issuance of improved and more detailed water-quality standards for municipal and industrial discharges (California Water Resources Control Board), will aid in future maintenance of good water quality.

The Corps of Engineers is conducting a sampling and analysis program in the project area to determine current water quality. The program includes stream sampling in the Yuba River below Englebright Dam, near the mouth of Dry Creek, and near the mouth of Deer Creek, and monthly sampling at New Bullards Bar and Englebright Lakes. Results of the sampling program are discussed in Appendix G.

o. Heavy metals - The Corps of Engineers contracted with BEAK Consultants, Inc., in December 1975 to conduct a study(2) to determine the levels of mercury, lead, and boron in water, sediments, plants, and animals in the project area and the probability that inundation of gold mining dredge tailings by the project and excavation of the riverbed for construction might release undesirable amounts of these elements into the environment. The sampling locations on Yuba River were at Rose Bar, upstream of the main concentration of dredge tailings, and at a site near Marysville below the dredge tailings. Samples were also taken from Long Bar and Gold Field Ponds in the tailings area and from Timbuctoo Pond upstream of the dredge tailings. (The Gold Field site was used for fish samples only.) Ponds were sampled because of the relative immobility of organisms and sediments in the ponds, as compared to those in the river, thereby representing good models to determine potential long-range problems. The following paragraphs summarize the results of the literature search and field testing. Details on the mercury, lead and boron study can be found in Appendix G.

The concentrations of mercury in water, sediments and biological materials were not greater than concentrations measured in comparable areas in California, and while some fish exceeded U.S. Food and Drug Administration (FDA) guidelines for human consumption, this cannot be considered unusual in light of measurements made elsewhere in California.(2)

Lead was present in detectable amounts in some sediment samples, algae, and willow leaf samples. However, the concentrations of lead measured were low and comparable with values measured in other unurbanized areas in California.

Boron levels in water were well below the national average and considerably less than the averages for the Sacramento River. Boron was present in detectable concentrations in some sediment samples, algae, and willow leaves, but, since it is a necessary micronutrient for the growth and development of many higher plants, it is toxic to only very sensitive species, unless present in very high concentrations.

p. Noise - Noise near the project site is principally from aircraft at nearby Beale AFB. Each day, Monday through Friday, there are approximately 375 airplane movements (take-offs + landings = 375). There are very few flights on weekends, and most flights take place between 8 a.m. and 5 p.m., with occasional night flights. Measurements of peak aircraft noise levels were made as part of a noise study in 1974 at a site near the intersection of Highway 20 and Spring Valley

Road, about 7 miles west of the Yuba River Dam.(3) Observed flight paths of planes approaching the base are shown in Figure E-4. Flight paths pass over the downstream reach of the Yuba River. Forty-six approaches were logged during a 3-hour period. Peak noise levels ranged from 56dBA to 98dBA, with a mean of 81dBA. Interim standards of the Department of Housing and Urban Development for external noise exposure for new residential construction indicate that noise levels not exceeding 65dBA for more than 8 hours per 24 hours are normally acceptable, but that noise levels above 65dBA for more than 8 hours per 24 hours are normally unacceptable for residential construction.(17) Areas south of the measurement site are subjected to peak levels greater than those measured, due to convergence on the flight paths and decreased altitudes of the planes. Areas under the flight paths north and east of the measurement site are subjected to lower noise levels, due to increased airplane altitude.

q. Flood control - Normal annual precipitation varies considerably across the Yuba River basin, ranging from a low of about 20 inches on the valley floor to over 90 inches at some higher elevations. The greater part of the precipitation occurs from October through April, with maximum amounts during December, January, February, and March. A large portion of the precipitation in the Yuba River watershed falls in the form of snow in the winter and melts during the spring and early summer. Major floods in the Yuba River basin occur during the winter months and are generally caused by intense rainstorms preceded by a period of rainfall.

Melting of antecedent snow cover augments peak flows and volumes of rain floods.

The flow that can be safely conveyed in the Yuba River downstream from the Marysville damsite depends on the condition of the levees and channel and the backwater effect from coincident flow in the Feather River. The Yuba River levees have a design capacity of 120,000 cfs with high backwater conditions, but flows up to 180,000 cfs have been carried safely under low backwater conditions (Dec 1964 flood).

The Yuba River enters the Feather River flood plain below the damsite. The flood plain, which is the area that has been or is susceptible to flooding by the Feather River and its tributaries, is estimated to encompass 337,000 acres and extends from where the Feather River leaves the Sierra foothills at Oroville to its confluence with the Sacramento River at Verona, 66 miles downstream. The Yuba River joins the Feather River at Marysville, 28 miles above its confluence with the Sacramento River. Although existing land use is primarily agricultural, about 50 percent of the total population of Yuba, Sutter, and Butte Counties is situated in the flood plain. The main urban centers--Marysville, Yuba City, part of Oroville, Linda, Olivehurst, Biggs, Gridley, and Live Oak--are located in the flood plain. The area susceptible to flooding by the standard project flood is shown in Figure E-5.

The most destructive flood of record for the Yuba River occurred during the period between 21 November and 10 December 1950. The levee

on the south bank of the Yuba River near Hammonton broke on 21 November, allowing about 43,200 acres to be inundated. The total loss due to this flood was over $4,000,000, of which $3,620,000 was below Englebright Dam.

The December 1955 flood was the most destructive flood on the Feather River flood plain. It occurred before the construction of Oroville or New Bullards Bar Dams. The maximum floodflows occurred at about the same time on the Feather and Yuba Rivers. The levee protecting Yuba City broke, and large parts of the city were inundated, along with about 100,000 acres of land. Thirty-eight people lost their lives, 3,300 houses were flooded, thousands were forced to evacuate, and flood damage was estimated at $50.5 million.

The December 1964 flood on the Feather River had the largest peak flow of record. However, outflow from the partially constructed Oroville Reservoir was reduced to 158,000 cfs. The Yuba River also reached record peak of about 180,000 cfs. The flood inundated about 25,000 acres of agricultural land in the floodway area between the levees and caused damages of about $5 million.

Information on these events and other recent major floods for the Yuba River is presented in Appendix F.

Most of the flood plain is protected by levees constructed or improved by the Corps of Engineers as part of the Sacramento River Flood

Control Project. Levee design capacities, which are the maximum nondamaging flows that can be conveyed by the levee system, are shown in the following tabulation.

Reach	Design Capacity, cfs
Yuba River at mouth	120,000
Feather River above Yuba River	210,000
Feather River below Yuba River	300,000
Feather River at mouth	320,000

The Yuba River floodway extends from where the river leaves the foothills to the junction with the Feather River. It is confined by levees on both banks, but the area between the levees is quite extensive except at Marysville, which is protected by a high ring levee. The floodway capacity in the lower 4-1/2 miles is affected by backwater from the Feather River. Sacramento River Flood Control Project levees are designed to have a minimum of 3 feet of freeboard at the design flow.

Flooding in the Marysville-Yuba City area is affected by the operation for flood control of two existing reservoirs in the Feather-Yuba River basin, Oroville Dam on the Feather River, with 750,000 acre-feet of flood storage reservation, and New Bullards Bar Dam on the North Yuba River, with a flood control storage reservation of 170,000 acre-feet. Flood control operation of New Bullards Bar Dam and Oroville Dam are fully coordinated under interim operating procedures.

r. Hydroelectric resources - California's electrical energy is supplied by a number of different types of generating facilities, most of which are connected to the major areas of demand by a common electrical transmission grid. Water originally was the primary source of electric power in California, and early hydroelectric developments were usually single-purpose plants built by electric utility companies. In the late 1920's construction of stream generating capacity increased rapidly, and after World War II progressively larger steam-powered generating plants were constructed. Today hydroelectric power provides about 30 percent of the total energy requirements of the State. In 1972 Californians used approximately 155 billion kilowatthours (kWh) of electric energy, with hydroelectric generation in California supplying about 32 billion kWh annually.(14) Additional energy generated in hydroelectric plants outside the State is imported each year over transmission interconnections of the Pacific Northwest and plants on the lower Colorado River.(14) Total hydroelectrical generating capacity in California in 1972 was 8,162 megawatts (MW).(14)

The Yuba River basin now has seven hydroelectric facilities. These are Lake Spaulding on the South Yuba River with three plants totalling 17 MW of installed capacity, Deer Creek above Scotts Flat Reservoir on Deer Creek with 6 MW, Colgate Powerplant below New Bullards Bar Dam on the North Yuba River with 284 MW, and the Narrows and New Narrows Powerplants below Englebright Dam with 9 and 47 MW, respectively.

Additional information on hydroelectric resources and power is presented in Appendix I.

s. Water resources and supply - A portion of the Browns Valley Irrigation District (BVID) is within the project area. BVID began operating in 1888, and rights to a portion (17,000 acre-feet per year) of the District's present water supply date back to that time, when it acquired the water rights and conveyance facilities from the owners of canals and ditches constructed by early mining interests.(4) The BVID contains about 46,000 acres; 16,000 acres are suitable for irrigation and, of this amount, nearly 10,000 acres are steep and require special irrigation practices. By 1970 the irrigated area reached 6,150 acres, considerably less than the amount expected with full development. The plan for the BVID assumes that the net area irrigated in any season would not exceed 11,100 acres.

Approximately 60 percent of the water presently used for irrigation in Yuba, Sutter, and Butte Counties is ground water, and the extensive use of ground water has caused lowering of the ground water table. Twenty-five years ago in Yuba County, the depth to water was less than 30 feet. Today, the depth ranges from 15 to 90 feet, with the bulk of the wells being below the 50-foot level.

The Yuba County Water Agency planned and constructed New Bullards Bar Dam and Reservoir, together with related water supply, power, and

recreation facilities as a part of the Yuba River Development Project in the late 1960's. The development was built with receipts from the sale of revenue bonds and from a Federal flood control grant and a State recreation grant. A power purchase agreement with Pacific Gas and Electric Company (PG&E) provides revenue to retire the bonds as they mature. Releases from the reservoir are made in accordance with the power purchase agreement and are designed to conform to the energy needs of PG&E. Releases from the powerplants flow downstream to be used for irrigation and other purposes.

With proposed reregulatory facilities, the YCWA can make available for sale below Englebright 172,100 acre-feet of Yuba River water generated by the New Bullards Bar project. The YCWA currently has contracts to sell approximately 35,000 acre-feet of this amount to various irrigation districts. One of these districts currently has no conveyance facilities for this water and must complete these facilities by 25 February 1978 or the contract is void. The remaining 137,000 acre-feet of water is unsold and flows down the Yuba River to the confluence of the Feather River. In addition to the 172,100 acre-feet, 25,000 acre-feet of new yield of the New Bullards Bar project has been allocated to seepage.

The YCWA is unable to sell or utilize more of its salable water at this time because it was unable to complete all of the proposed facilities for its Yuba River Development Project that included the

New Bullards Bar project. Planned facilities not constructed as a part of the Yuba River Development Project were:(21)

1. An irrigation diversion works, including an afterbay in the area of Smartville, for the reregulation of water from power usage for irrigation.

2. The New York Flat project, including a 90-foot high dam and associated facilities that would increase available water for the Yuba County Water District which is headquartered in Brownsville.

3. The North Yuba Canal and pumping plant to take water north of the Yuba River to irrigation users.

4. The South Yuba Canal System to take water south of the Yuba River to irrigation users.

Without the reregulation facilities, the YCWA is unable to reregulate the flow of water released from New Bullards Bar Dam for power, and peak flows for power production do not coincide with peak irrigation demands from April to October. The following tabulation shows the amount of sold and unsold YCWA water in acre-feet.(22) The Ramirez Irrigation District is included in the table because it has contracted with the YCWA for water. Its water contracts by month in acre-feet are not included in the Water Sold Total column since it has not started consuming its

contracted water. However, it can be assumed that the Ramirez Irrigation District will provide facilities for obtaining the water before its contract deadline in 1978.

Month	Cordua Irrigation District	Marysville City Wilbur Di Giorgio	(Ramirez Irrigation District)	Available Agency Water for Sale	Water Sold Total	Remaining Water for Sale by Agency
April	900	820	(2,010)	38,100	1,720	36,380
May	2,120	1,085	(3,270)	27,710	3,205	24,505
June	2,080	1,540	(2,745)	25,700	3,620	22,080
July	2,620	1,590	(1,920)	5,660	4,210	1,450
August	2,600	1,567	(1,755)	6,560	4,167	2,393
September	1,180	1,105	(1,500)	10,500	2,285	8,215
October	500	387	(700)	2,900	887	2,013
Total	12,000	8,094	(13,900)	117,130	20,094	97,036

Two facts are evident from this table: (1) the majority of YCWA's salable water (78 percent of available agency water for sale) flows in April, May and June, leaving only 22 percent of the remaining salable water to flow from July to October; (2) after present YCWA water is sold, plus the additional water allocation for the Ramirez Irrigation District, the YCWA over-allocates water to its contracts by 470 acre-feet in July.

This is critical for future YCWA water contracts to other irrigation users because it would require flow release changes from New Bullards Bar Dam. This would result in power production changes by PG&E. The 117,130 acre-feet of available agency water for sale is the maximum amount of water that the YCWA can utilize without seriously altering the present power production requirements of PG&E. These conditions are caused by the lack of a downstream regulating facility.

2. Existing water resources developments. -

a. Daguerre Point Dam. - Daguerre Point Dam is a part of the Yuba River Debris Control project, authorized for construction by the River and Harbor Act of 1902, with one-half the cost of construction borne by the United States and one-half by the State of California. Daguerre Point Dam is located on the Yuba River, a tributary of the Feather River, approximately 11 miles upstream from the city of Marysville, California. The original design of the dam was a broad crested weir consisting of a 40-foot wide reinforced concrete stepped slab about 3 feet thick, with upstream and downstream cutoff walls, set on short 2-foot square cast-in-place concrete piles 13 feet on centers both ways. The total drop over the broad crest of the dam was 3 feet. The slab was constructed across the inlet end of a 660-foot wide rock diversion cut through Daguerre Point promontory. The cut was about 1,000 feet long, and averaged 25 feet in depth.

The original dam was completed in 1906 by the California Debris Commission and served to create a basin for the storage of debris originating in the operation of hydraulic gold mining. Between 1937 and 1952 fishways and an irrigation diversion structure were added. After hydraulic gold mining came to an end, the dam served the purpose of retaining the existing upstream debris and diverting water for irrigation. In February 1963 a flood washed out a section approximately 120 feet wide near the center of the dam, and the entire dam was reconstructed, except for a short segment of the right abutment consisting of a fishway and diversion structure. The reconstruction program was completed in December 1964. In late December 1964 a flood washed out the Hallwood-Cordua Diversion Structure and a portion of the right bank fishway. Permanent repairs of the diversion structure and right bank were completed in October 1965. The reconstructed dam consists of an overflow concrete ogee spillway with crest at elevation 125.3 msl, a concrete apron at elevation 101.0, and concrete abutments, concrete fishways (one on each abutment), and a locally-owned and operated irrigation diversion structure on the right abutment.

b. Harry L. Englebright Dam and Narrows I and Narrows II Powerplants. - Harry L. Englebright Dam was authorized by the Rivers and Harbors Act of 1935, to be constructed as part of the project for Sacramento River and Tributaries Debris Control project. The dam is located on the Yuba River about 20 miles northeast of the city of Marysville. Construction of the dam was started in 1938 and completed in 1941. Englebright Dam was built for the primary purpose of controlling

debris resulting from upstream hydraulic mining operations. Outlet facilities were provided to permit releases from the reservoir for the generation of hydroelectric power. Since project completion, there has been practically no upstream mining activity, and the reservoir has been used for the secondary purposes of power and recreation. Debris which has been deposited in the reservoir, due to the natural movement of material from upstream areas, is minor and does not affect the use of the reservoir.

Englebright Dam is a concrete constant-angle arch dam of the overflow type. The dam rises 260 feet above the lowest foundation and has a crest elevation of 527 feet msl. The total crest length is 1,142 feet and the thickness varies from 80 feet at the base to 21 feet at the crest. The power outlet consists of a reinforced concrete inlet structure connected to a reinforced concrete-lined tunnel leading to the PG&E Narrows I Powerplant. The overflow section of the dam is depressed 15 feet and has a length of 506.4 feet. It is provided with four aeration piers to admit air underneath the overflowing water. The spillway capacity is 110,000 cfs with zero freeboard. The spillway design flood of 350,000 cfs would result in 8 feet of water over the non-overflow section.

In May 1970 the YCWA completed the Narrows II Powerplant approximately 400 feet downstream of the right abutment. These facilities will utilize releases from the Colgate Powerplant for power generation as regulated by New Bullards Bar Dam, 15 miles upstream. Water is delivered to the Narrows II Powerplant from the 120-foot high reinforced concrete

intake structure, located about 200 feet upstream of the dam, through a 737-foot long power tunnel. The 369 feet of tunnel extending from the intake to the dam axis is an 18'-4" diameter concrete lined horseshoe tunnel. This tunnel then transitions into a 14-foot diameter steel-lined tunnel extending the remaining 368 feet to the powerhouse. Capacities of the two privately owned powerplants are:

Narrows I	9,350 kW
Narrows II	46,700 kW

The PG&E owns Narrows I Powerplant, and the YCWA owns Narrows II Powerplant. Both have a contractual right to control reservoir storage and the pool elevation behind the dam between elevation 527 feet msl (maximum pool) and 450 feet msl (minimum operating pool), about 45,000 acre-feet, depending upon demand. Historically, power use has resulted in a drawdown of 30 to 40 feet during the latter half of the recreation season, and on several occasions, by as much as 77 feet by October. However, since completion of New Bullards Bar Dam in January 1970, recreation season drawdown has averaged 6 feet and has rarely exceeded 15 feet. At gross pool, Englebright Lake is 9 miles long, has a surface area of 815 acres, a shoreline 24 miles long, and contains 70,000 acre-feet of water. Inactive pool is at elevation 438 feet with a surface area of 350 acres, length of 3 miles and a capacity of 20,000 acre-feet. Project lands total 3,329 acres, of which 1,783 acres are held in fee or are withdrawn public domain and 1,546 acres are in flowage easement.

The YCWA is required, by agreement with the California Department of Fish and Game, to release sufficient water from Englebright (which may pass through the powerhouse) to maintain a flow of at least 70 cfs during a "critical dry year" over Daguerre Point Dam for the maintenance of fishlife. During "normal water years" flows in the Yuba River at the confluence with the Feather River must be 400 cfs from 1 October to 31 December and 245 cfs from 1 January to 31 March.

c. Sacramento River Flood Control Project. - The Sacramento River Flood Control Project was authorized by the Flood Control Act of 1917 and modified by Flood Control and/or River and Harbor Acts in 1928, 1937, and 1941. Construction of the project was initiated in fiscal year 1918, and all major project items are completed. Approximately 977 miles of levees have been transferred to the State of California for maintenance. It is a joint Federal-State-local interests venture and incorporates flood-control works undertaken by local interests prior to adoption of the project in 1917. Local costs include rights-of-way, utility relocations, original construction undertaken by local interests, and the cash contributions toward construction costs made prior to 1941.

The project comprises a comprehensive system of levees, overflow weirs, drainage pumping plants, and flood bypass channels, extending along the Sacramento River from Collinsville (mile 0) to Ord Bend (mile 184), and along the lower reaches of principal tributaries; together with channel clearing, rectification, snagging, and bank protection on the

Sacramento River and tributaries. The project includes approximately 980 miles of levee construction (including 170 miles of levees on the Feather River and tributaries) providing flood protection to about 800,000 acres of highly productive agricultural lands, to the cities of Marysville, Yuba City, and Sacramento, and to numerous smaller communities.

The Yuba River is leveed from its mouth to upstream high ground, a distance of about 7 miles, and a ring levee has been constructed around the city of Marysville. Levees along Yuba River, were initially constructed by local interests and later raised, lengthened, and strengthened as a part of the Sacramento River Flood Control Project. The design channel capacity of Yuba River where leveed is 120,000 cfs.

d. Central Valley Project. - The Central Valley Project (CVP) of the U.S. Bureau of Reclamation (USBR) (Figure E-6) is a multiple-purpose development and includes the storage and transfer of surplus waters from the Sacramento and Trinity River Basins to the water-deficient lands of the San Joaquin River and Tulare Lake Basins.

In 1873, following a severe drought in the Central Valley, Congress authorized the Alexander Commission to study the Sacramento and San Joaquin Rivers. The report of that study outlined a system of irrigation-water supply works, stressing the necessity of coordinated planning, and suggested Federal assistance. Such Federal assistance to western irrigation planning was authorized by Congress with the adoption

of the Reclamation Act of 1902, creating the Reclamation Service, later the USBR. The Marshall Plan, published in 1920, made a significant contribution to comprehensive State water planning. Essentially the basis for the present-day CVP, this plan proposed a large-scale public works project to supply water for the Sacramento and San Joaquin Valleys. In 1933 the State Legislature approved the Central Valley Project Act providing for the construction of Shasta Dam and powerplant, Friant Dam and powerplant, a transmission line, and other works. The depression of the 1930's, however, made State financing of such a plan impossible. Following State appeal, Congress, in 1937, appropriated funds and authorized construction and operation of the CVP by the U. S. Bureau of Reclamation, and construction began in 1937.

The main multiple functions of the CVP are to provide a dependable, ample, year-round supply of water for irrigation in the Central Valley, and for municipal and industrial uses, but the facilities which store and deliver this water provide additional benefits, including power, flood control, navigation, fish and wildlife enhancement, recreation, water quality control, and environmental protection and preservation. To coordinate operation, project powerplants are tied together by a 230-kV transmission system which also interconnects with lines of other power utilities in the area. This system is further interconnected with the Pacific Northwest-Pacific Southwest (PNW-PSW) Intertie which interconnects the hydroelectric projects in the Columbia River Basin, the California power systems including the CVP, and the Colorado River Basin systems.

The CVP's portion of the PNW-PSW Intertie consists of a 500-kV transmission line from the Oregon border to Round Mountain Substation and a 230-kV transmission line from Round Mountain to Cottonwood Substation.

The physical features of the CVP include dams and reservoirs, pumping plants, canals, and generating facilities. The Federal CVP and the California State Water Project share the use of several facilities. The main source of CVP project water to satisfy CVP demands is Shasta Reservoir. Shasta releases to the Sacramento River are augmented by a cross-basin transfer of Trinity River water to Keswick Reservoir 11 miles downstream from Shasta Dam. Estimates of uses are made, based upon previous historical occurrences, and operation of the project facilities reflects these estimates in assuring that sufficient flows are maintained at the navigation control point and that the inflow to the Sacramento-San Joaquin Delta is adequate to meet the internal Delta and export needs with sufficient Delta outflow to protect the region from salinity intrusion.

The CVP power facilities consist of seven powerplants and two pumping-generating plants with an installed capacity (nameplate) of 1,334,000 kW. Most of the powerplants are located just downstream from the CVP storage reservoirs and are operated in conjunction with the water demands made on these reservoirs. Reclamation policy requires that CVP reservoirs be operated with major emphasis on meeting water demands associated with the other multiple-purpose functions, and the generation of electric power is for the most part a byproduct.

Power generated at CVP powerplants is directly related to the demands for project water. Recognizing that these water demands would be seasonal (with much larger releases being made during the summer months), CVP powerplants were designed to generate peaking power. Since peaking power alone cannot satisfy the power requirements of CVP power customers, and since peaking power is more efficiently used when integrated with baseload power, the Bureau entered into a support contract, No. 14-06-200-2948A (Contract 2948A), with PG&E. Contract 2948A provides for the delivery of peaking power from CVP powerplants into the PG&E system and PG&E, in return, delivers power as required, to CVP customers. The electric power generated by CVP powerplants is dedicated first to meeting the power requirements of the project facilities (project use). The power remaining after meeting project use, is used to provide commercial power to various preference customers, (military installations, irrigation districts, municipalities, and various Federal and State Government installations) in northern California.

Regulations for operation of Bureau of Reclamation CVP reservoirs for the control of floods are established by cooperative agreement between the USBR and Corps of Engineers. Flood control regulations for the operation of Shasta, Friant, and Folsom Dams and Reservoirs were published in the Federal Registers dated 3 January 1953, 10 December 1955, and 20 June 1956, respectively. A memorandum of agreement dated 29 December 1958, between the Department of the Army and the Department of the Interior on "Division of Responsibilites in the Central Valley Basin, California,"

establishes principles, procedures, and designations of responsibility applicable to the conduct of water development programs of the Corps of Engineers and USBR. This memorandum provides for flood control operation under Corp's regulations.

The firm annual water supply of the CVP, including Clair Engle, Shasta, Folsom, Auburn, Whiskeytown, and San Luis Reservoirs, has been considered to be 9,250,000 acre-feet available for the Sacramento and American River Basins and the Sacramento-San Joaquin Delta. The total water supply expected to be available from the existing and authorized Federal CVP facilities is 11,407,116 acre-feet annually, including prior vested rights water.

e. California State Water Project. - Comprehensive investigations of the water resources of California were first made by the State Engineer in the 1920's. A report giving results of investigations and outlining revised proposals was published in 1930 as Division of Water Resources Bulletin No. 25, entitled, "Report to Legislature of 1931 on State Water Plan." It outlined a coordinated plan for conservation, development, and utilization of the water resources of California. In 1941 the plan was adopted by the Legislature and designated the "State Water Plan." In 1947, the Statewide Water Resources Investigation was initiated by the Division of Water Resources for the State Water Resources Board in response to legislation enacted in 1945 and 1947. This investigation included evaluating the water resources of California,

determining present and probable ultimate water requirements, and formulating plans for development of the State's water resources to meet ultimate water requirements. The State, in 1951, selected the California State Water Project (SWP) (first known as the Feather River Project) as a feature of the California Water Plan to be constructed by the State. The SWP is shown on Figure E-7. The final phase of the Statewide Water Resources Investigation was presented in 1957 as "The California Water Plan."(11) The report describes a comprehensive master plan to guide and coordinate the planning and construction of works required for the control, protection, conservation, and distribution of the water of California, to meet present and future needs for beneficial uses in all areas of the State.

In 1959 the Legislature enacted the California Water Resources Development Bond Act, known as the Burns-Porter Act, which authorized the construction and operation of the SWP. The SWP includes the following:

	Scheduled Completion Date[1/]
Feather River Facilities	
Upper Feather Division	1983
Oroville Division	Complete
Delta Facilities	1986
North Bay Aqueduct	1980
South Bay Aqueduct	Complete
California Aqueduct	
North San Joaquin Division	1985
San Luis Division	1985
South San Joaquin Division	1976
Tehachapi Division	1983
Mojave Division	1985
Santa Ana Division	1976
West Branch	1981
Coastal Branch	1981
San Joaquin Drainage Facilities	Not yet scheduled

1/ Dept of Water Resources Bul. No. 135-75, The California Water Project in 1975, June 1975.

The SWP facilities include 23 dams and reservoirs, 8 powerplants, 22 pumping plants, and 684 miles of aqueducts. These facilities are designed to readjust the imbalance of California's water resources and water needs. Seventy percent of California's water supply originates in the northern third of the State, and 77 percent of the water need is in the southern two-thirds.

The Oroville Division, which is the Division of the SWP most closely related to the Marysville Lake project, includes the following major units: Oroville Dam and Reservoir, Oroville Powerplant, Thermalito Diversion Dam, Thermalito Canal, Thermalito Forebay, Thermalito Powerplant, Thermalito Afterbay, and the Feather River Hatchery.

Oroville Dam is located about 4 miles northeast of the city of Oroville. The dam is an embankment structure with impervious rolled fill core and graded gravel shell, approximately 735 feet in height with a crest length, including the spillway, of 6,800 feet. The reservoir has a surface area of 15,500 acres, a shoreline of 167 miles, and a storage capacity of 3,484,000 acre-feet at normal pool elevation of 900 feet msl. A gated spillway is located in a saddle on the right abutment. The spillway, incorporating the flood control outlet structure, consists of a 380-foot spillway, controlled by radial gates, and five low-level flood control outlets 27 feet wide by 34 feet high. Two auxiliary earthfill dams are located at low points on the rim of the reservoir.

Oroville Powerplant is an underground plant located in the left abutment of the dam. Oroville Powerplant is designed for pumped storage operation; the power installation consists of 6 units, with a total net generating capacity of 600,000 kW.

The Thermalito Diversion Dam, maintains tailwater at the Oroville Powerplant and diverts water to the Thermalito Canal serving the Thermalito Powerplant. The diversion dam is a concrete gravity structure 133 feet high and 1,280 feet long, with a gated spillway controlled by 14 40x23-foot radial gates. The outlet works provide for a downstream release of 400 cfs for preservation of the fishery in the Feather River. The reservoir has a surface area of 330 acres, a storage capacity of 13,500 acre-feet, and a shoreline of 10 miles.

The Thermalito Canal conveys water from Thermalito Diversion Dam to Thermalito Forebay. The canal is concrete-lined and is designed to permit flow in either direction to allow the return of water stored in Thermalito Afterbay to Oroville Powerplant during the pumped storage cycle.

The Thermalito Forebay has a gross capacity of 11,400 acre-feet impounded by an earthfill dam 65 feet high. The forebay dam provides head for the Thermalito Powerplant and functions essentially as an extension of the Thermalito Canal. Surface area of the forebay is about 775 acres, and the shoreline is about 9 miles long.

The Thermalito Powerplant contains one turbine unit and two reversible pump-turbines, with a total generating capacity of 98,000 kW. The plant operates on essentially the same schedule as the Oroville Powerplant and passes the same flows. An unlined tailrace channel connects the powerplant with the Thermalito Afterbay.

The Thermalito Afterbay is impounded by an earthfill dam 30 feet high and about 6 miles long. Gross storage capacity is 57,500 acre-feet, and active storage capacity is 45,000 acre-feet. The water surface area is about 4,500 acres, with a shoreline about 28 miles long. Outlet structures serve the Western Canal and the Sutter-Butte Canal, and discharge to the Feather River is regulated at the river return outlet.

The Feather River Hatchery is located on the right bank of the river below the Thermalito Diversion Dam. The hatchery serves to maintain the Feather River salmon and steelhead runs in lieu of the spawning areas inundated or disturbed by project construction.

f. Yuba River Development Project. - The YCWA planned and constructed the Yuba River Development Project in the late 1960's, including New Bullards Bar Dam and Reservoir and related water supply, power, and recreation facilities. The development was built with receipts from the sale of revenue bonds, a Federal flood control grant, and a State recreation grant. A power purchase agreement with PG&E provides revenue to retire the bonds as they mature. Releases from the reservoir are made

in accordance with the power purchase agreement and are designed to conform to the energy needs of PG&E. Releases from the powerplants flow downstream to be used for irrigation and other purposes. The functional units of the Yuba River Development Project are:

New Bullards Bar Project - The main feature is the 645 foot high New Bullards Bar Dam, a concrete arch structure 2,200 feet long, with a spillway height of 630 feet. The capacity of the impounded reservoir is 960,000 acre-feet, with 170,000 acre-feet operated for flood control. Spillway capacity is 160,000 cfs, and maximum normal water surface elevation is 1,955 feet msl. Adjustable level outlets control temperature and quantity of releases through the power penstock and a 26-foot diameter, 21,678-foot Colgate Tunnel to the New Colgate Powerhouse. New Bullards Bar Reservoir has a surface area of 4,600 acres and a 55-mile shoreline. Recreation facilities include three camping areas with 96 campsites; two picnic areas with 60 picnic units; five group campsites; two boat launching ramps of two lanes each, and roads, parking areas, and administration facilities.

Middle Yuba-Oregon Creek Diversion Project - North Yuba River flows feeding into New Bullards Bar Reservoir are augmented through the 14.5-foot diameter, 6,107 foot long, new Camptonville Tunnel by Oregon Creek water (diverted by the 55-foot high concrete Log Cabin Dam) and through the 12.5-foot diameter, 19,410 foot long Lohman Ridge Tunnel by Middle Yuba River water (diverted by the 75-foot high concrete Hour House Dam).

New Colgate Project - The New Colgate Powerhouse utilizes the 1,306 foot head of water stored and regulated from New Bullards Reservoir. The power installation has two impulse turbines operating under 1,306 feet of head, with an installed capacity of 284,000 kW. The plant is operated as a peaking plant, using Englebright Lake downstream as a reregulating pool.

Narrows II Project - The Narrows II Powerplant uses regulated releases from New Bullards Bar Reservoir through Englebright Lake. An intake and penstock constructed at Englebright Dam release water to the New Narrows Powerplant just below the right abutment of the dam. The plant has a single Francis turbine operating under 236 feet of head, with an installed capacity of 47,000 kW. There is no afterbay facility, and the plant is operated as a base load plant.

g. Other developments by local interests. - The Browns Valley Irrigation District (BVID) contracted with the USBR in 1960 for a loan for construction of Virginia Ranch Dam and Collins Reservoir on Dry Creek, a 3,800-foot tunnel, new canals, a pumping plant, and enlargement of existing canals, all for the purpose of delivering irrigation water to lands within the District. Virginia Ranch Dam was completed in 1963, and the distribution system was completed in 1965. Virginia Ranch Dam provides gross storage of 57,000 acre-feet, with a firm irrigation yield of 31,400 acre-feet.

In addition to New Bullards Bar Dam and Virginia Ranch Dam, local interests have constructed 18 reservoirs with storage capacity of 1,000 acre-feet or more in the Yuba basin for storage, regulation, and diversion of streamflow; for production of hydroelectric power; and for mining, irrigation and domestic use. These existing reservoirs provide a combined storage capacity of about 292,000 acre-feet. Most important among the reservoirs are Lake Spaulding, 74,500 acre-feet; Bowman Lake, 68,000 acre-feet; Fordyce Lake, 46,700 acre-feet; and Scotts Flat, 27,400 acre-feet.

APPENDIX E

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(11) State of California, Department of Water Resources, Bulletin No. 3, The California Water Plan, 1957.

(12) State of California, Department of Water Resources, Central District Office.

(13) State of California, Department of Water Resources, Office Report, Climate of the Yuba-Bear River, 1961.

(14) State of California, Department of Water Resources, Hydroelectrical Energy Potential in California, Bulletin No. 194, March 1974.

(15) State of California, Department of Water Resources, Yuba and Bear River Investigations, Bulletin No. 115, 1964.

(16) State of California, Division of Mines and Geology, Oroville, California, Earthquake, 1 August 1975, Special Report 124, 1975.

(17) U.S. Department of Housing and Urban Devlopment, Aircraft Noise Impact, Planning Guidelines for Local Agencies, November 1972.

(18) U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife, Division of River Basin Studies, Preliminary Draft Report on the Benefits and Losses Attributable to Four Different Pool Sizes of the Proposed Marysville Reservoir on the Yuba River, Sacramento (unpublished report), 1973.

(19) U.S. Department of Interior, Geological Survey, Water Resources Data for California, Part II, Water Quality.

(20) Wright, M.E., Species Checklists prepared for University of California's Sierra Foothill Range Field Station, 1968-69.

(21) Yuba County Grand Jury Final Report, 1972.

(22) Yuba County Water Agency, Letter dated 20 November 1975.

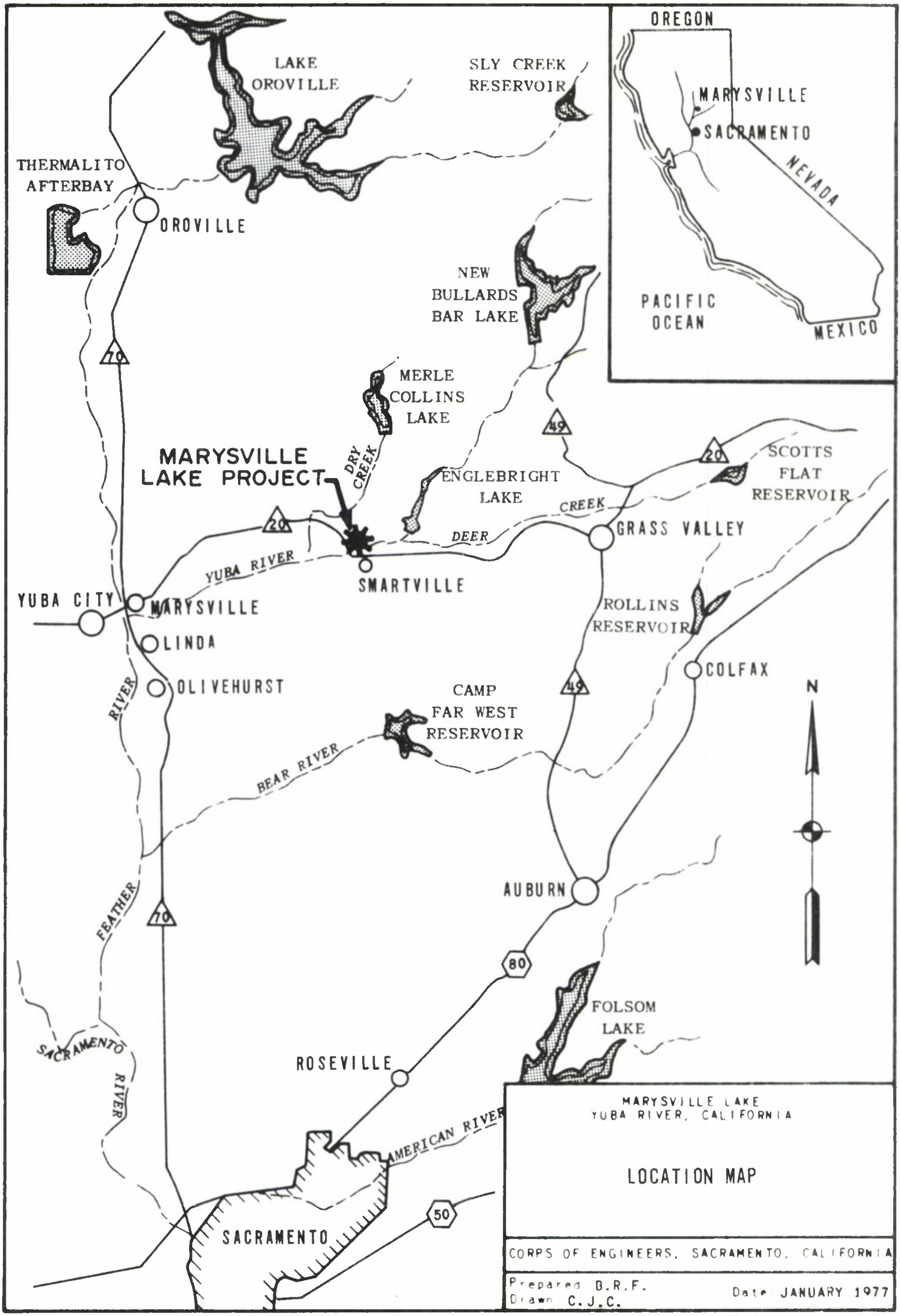
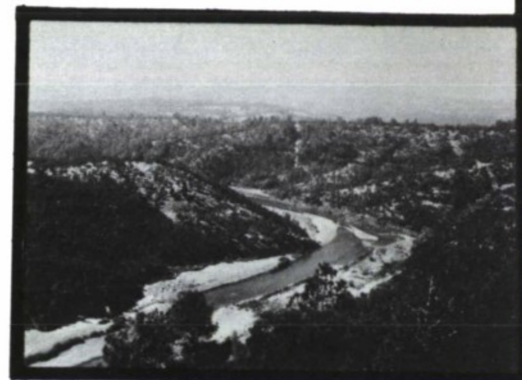

LAKE OROVILLE
SLY CREEK RESERVOIR
THERMALITO AFTERBAY
OROVILLE
NEW BULLARDS BAR LAKE
MERLE COLLINS LAKE
MARYSVILLE LAKE PROJECT
DRY CREEK
ENGLEBRIGHT LAKE
DEER CREEK
GRASS VALLEY
SCOTTS FLAT RESERVOIR
YUBA RIVER
SMARTVILLE
YUBA CITY
MARYSVILLE
LINDA
OLIVEHURST
ROLLINS RESERVOIR
COLFAX
CAMP FAR WEST RESERVOIR
BEAR RIVER
FEATHER RIVER
AUBURN
FOLSOM LAKE
ROSEVILLE
SACRAMENTO RIVER
AMERICAN RIVER
SACRAMENTO
70
20
49
80
50
N
OREGON
MARYSVILLE
SACRAMENTO
NEVADA
PACIFIC OCEAN
MEXICO
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
LOCATION MAP
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared B.R.F.
Drawn C.J.C.
Date JANUARY 1977

FIGURE E-1

1 DRY CREEK NEAR HIGHWAY 20

5 WELLS FARGO BUILDING IN TIMBUCTOO

2 DRY CREEK NEAR DAMSITE



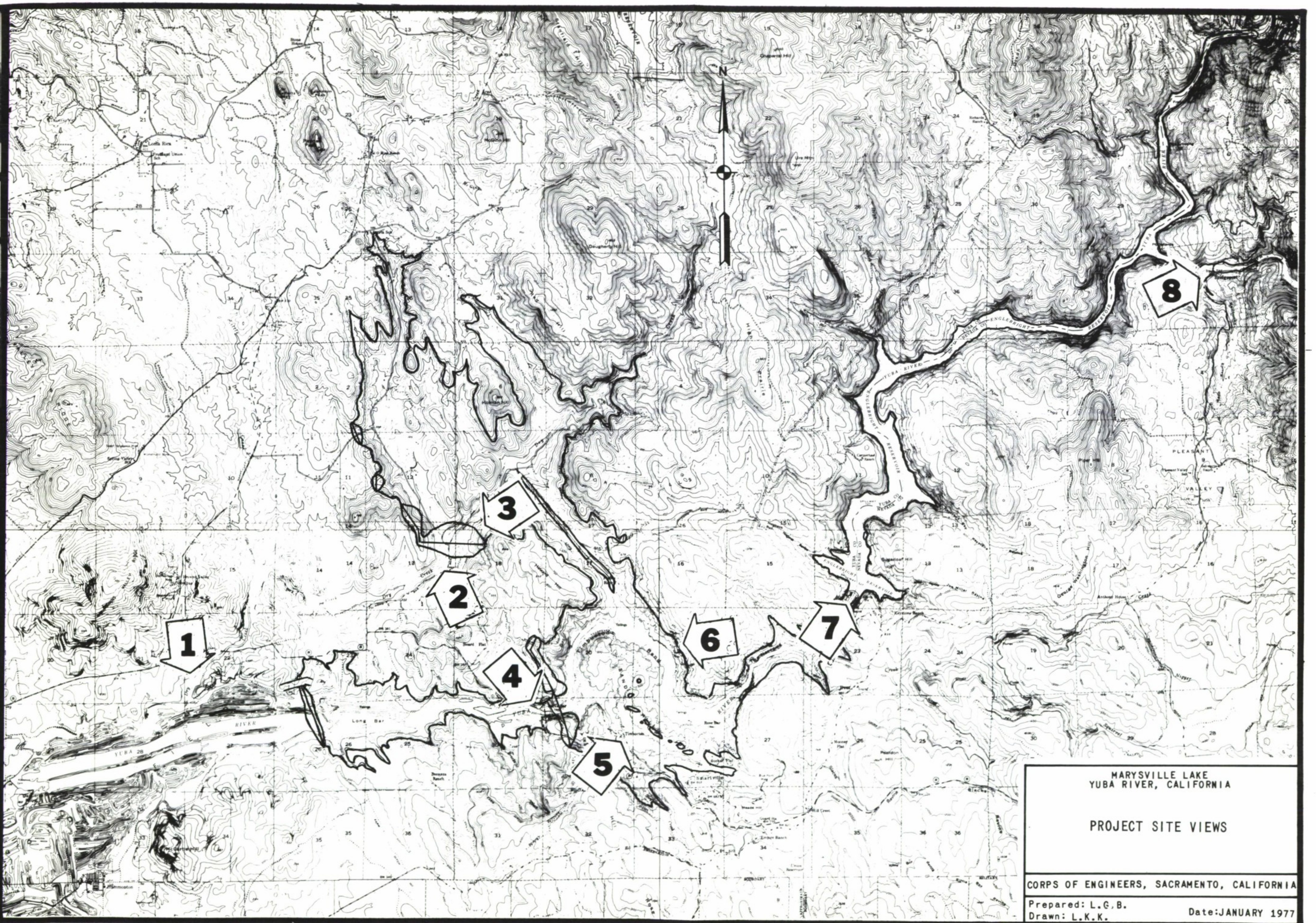
6 YUBA RIVER AT TIMBUCTOO BEND

3 AREA NEAR DRY CREEK DAMSITE

7 HARRY L. ENGLEBRIGHT DAM

4 PARKS BAR BRIDGE

8 COVERED BRIDGE AT BRIDGEPORT



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

PROJECT SITE VIEWS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE E-2

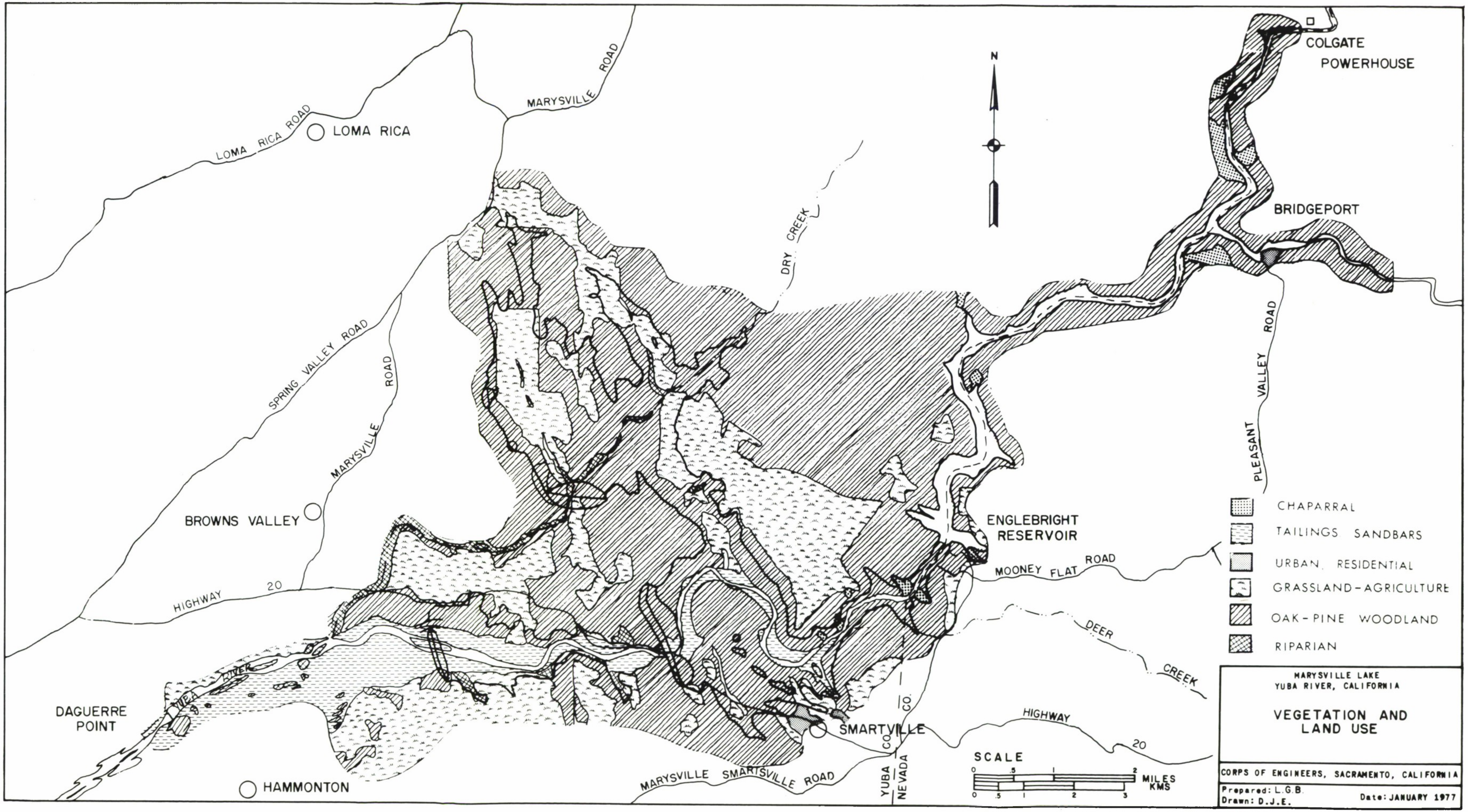

COLGATE POWERHOUSE
BRIDGEPORT
PLEASANT VALLEY ROAD
ENGLEBRIGHT RESERVOIR
MOONEY FLAT ROAD
DEER CREEK
DRY CREEK
MARYSVILLE ROAD
LOMA RICA ROAD
LOMA RICA
SPRING VALLEY ROAD
MARYSVILLE ROAD
BROWNS VALLEY
HIGHWAY 20
DAGUERRE POINT
HAMMONTON
YUBA RIVER
MARYSVILLE SMARTSVILLE ROAD
SMARTVILLE
YUBA CO.
NEVADA CO.
HIGHWAY 20
N
SCALE
MILES
KMS
CHAPARRAL
TAILINGS SANDBARS
URBAN, RESIDENTIAL
GRASSLAND-AGRICULTURE
OAK-PINE WOODLAND
RIPARIAN
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
VEGETATION AND LAND USE
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L.G.B.
Drawn: D.J.E.
Date: JANUARY 1977

FIGURE: E-3

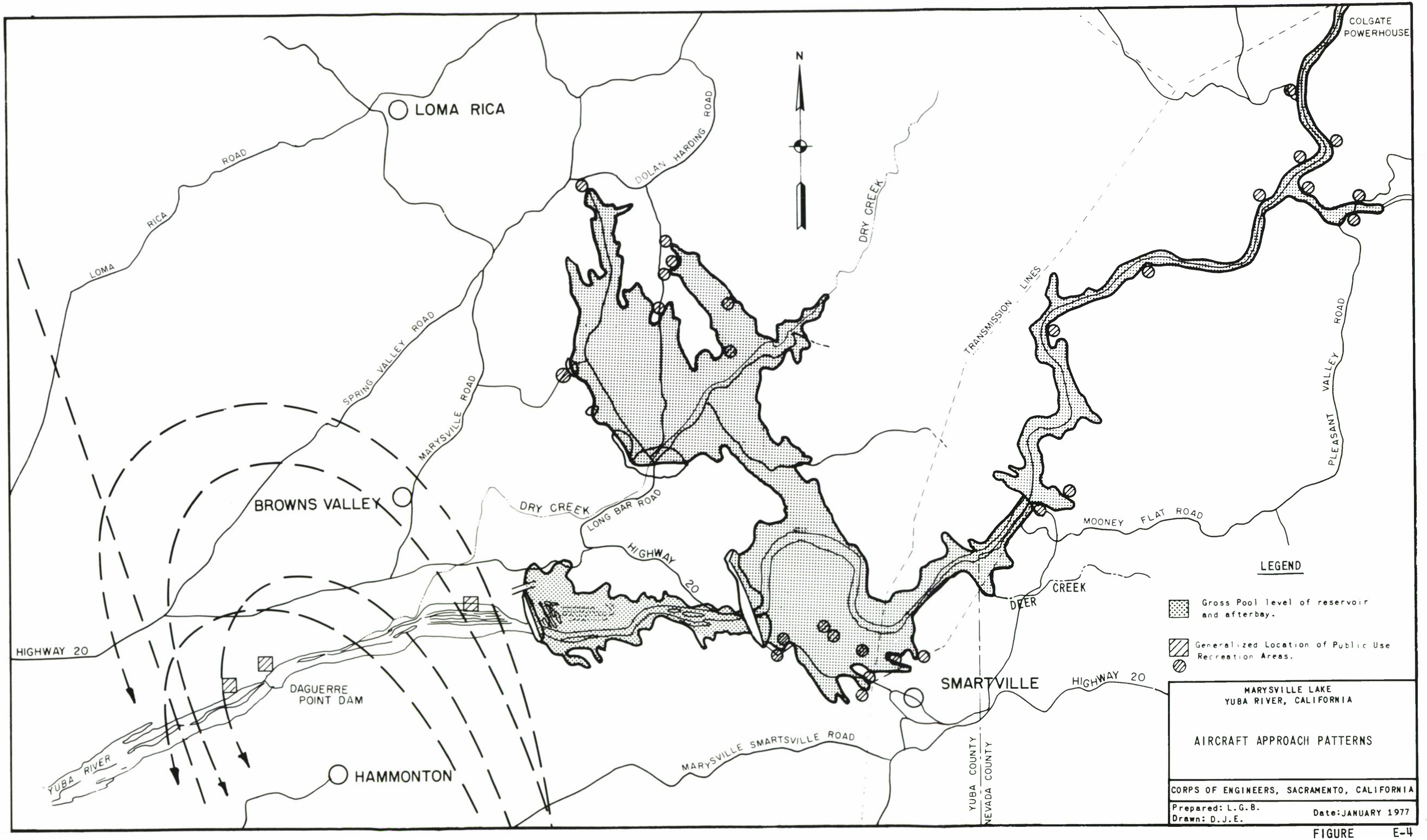

COLGATE POWERHOUSE
LOMA RICA
LOMA RICA ROAD
DOLAN HARDING ROAD
N
DRY CREEK
SPRING VALLEY ROAD
MARYSVILLE ROAD
TRANSMISSION LINES
PLEASANT VALLEY ROAD
BROWNS VALLEY
DRY CREEK
LONG BAR ROAD
HIGHWAY 20
MOONEY FLAT ROAD
LEGEND
DEER CREEK
Gross Pool level of reservoir and afterbay.
Generalized Location of Public Use Recreation Areas.
HIGHWAY 20
DAGUERRE POINT DAM
SMARTVILLE
HIGHWAY 20
MARYSVILLE SMARTSVILLE ROAD
YUBA RIVER
HAMMONTON
YUBA COUNTY
NEVADA COUNTY
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
AIRCRAFT APPROACH PATTERNS
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L.G.B.
Drawn: D.J.E.
Date: JANUARY 1977

FIGURE E-4

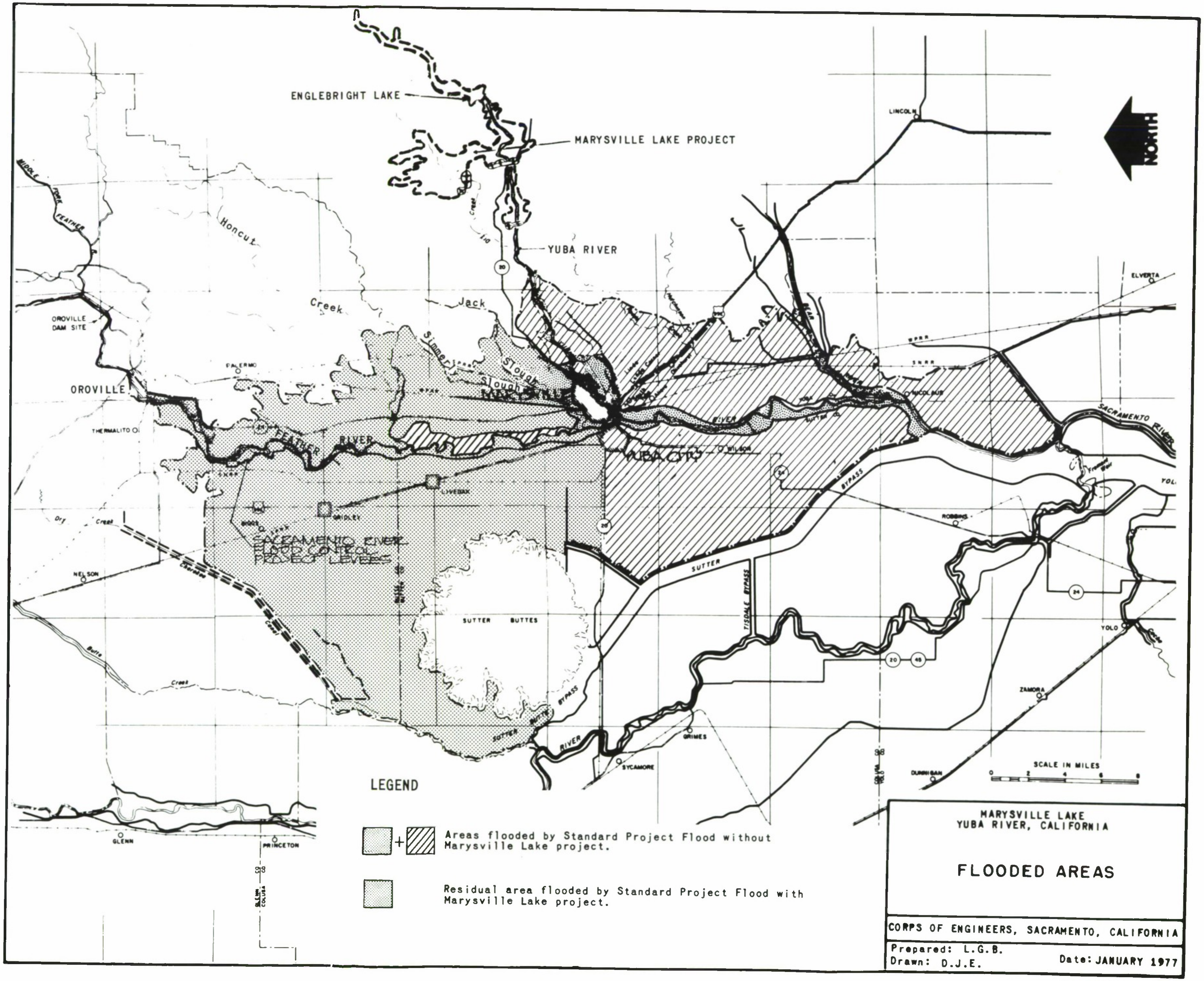

NORTH
ENGLEBRIGHT LAKE
MARYSVILLE LAKE PROJECT
YUBA RIVER
OROVILLE
OROVILLE DAM SITE
THERMALITO
PALERMO
LINCOLN
ELVERTA
NICOLAUS
WILSON
YUBA CITY
LIVE OAK
GRIDLEY
BIGGS
NELSON
SUTTER BUTTES
GRIMES
SYCAMORE
DUNNIGAN
ZAMORA
YOLO
ROBBINS
GLENN
PRINCETON
MIDDLE FORK FEATHER R.
FEATHER RIVER
SACRAMENTO RIVER
Honcut Creek
Jack
Simmerly Slough
Slough
Dry Creek
Butte Creek
SUTTER BYPASS
TISDALE BYPASS
SUTTER BUTTE BYPASS
SACRAMENTO RIVER FLOOD CONTROL PROJECT LEVEES
SCALE IN MILES
0 2 4 6 8
LEGEND
Areas flooded by Standard Project Flood without Marysville Lake project.
Residual area flooded by Standard Project Flood with Marysville Lake project.
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
FLOODED AREAS
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L.G.B.
Drawn: D.J.E.
Date: JANUARY 1977

FIGURE E-5

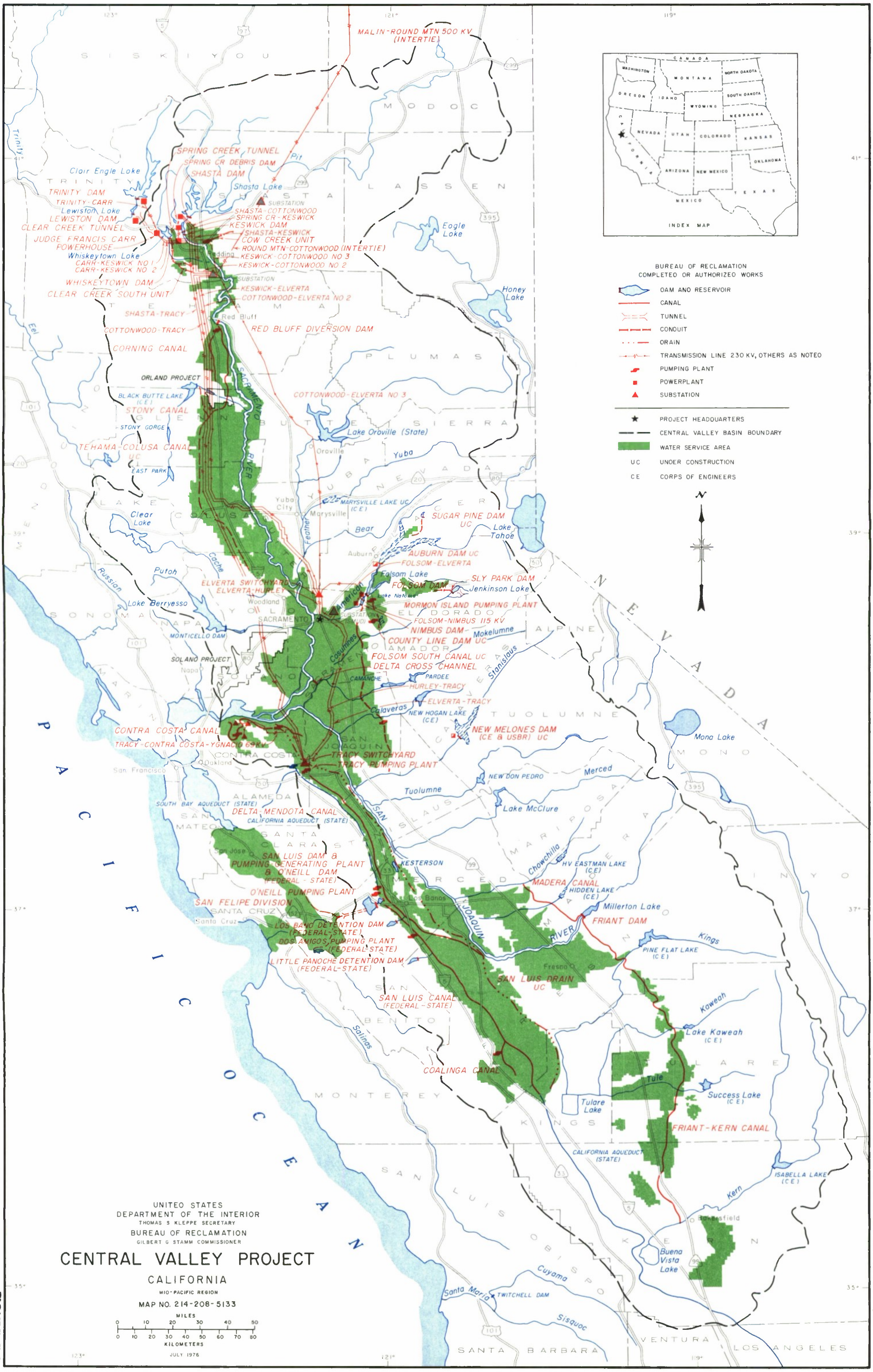

UNITED STATES
DEPARTMENT OF THE INTERIOR
THOMAS S KLEPPE SECRETARY
BUREAU OF RECLAMATION
GILBERT G STAMM COMMISSIONER
CENTRAL VALLEY PROJECT
CALIFORNIA
MID-PACIFIC REGION
MAP NO. 214-208-5133
MILES
KILOMETERS
JULY 1976
INDEX MAP
BUREAU OF RECLAMATION
COMPLETED OR AUTHORIZED WORKS
DAM AND RESERVOIR
CANAL
TUNNEL
CONDUIT
DRAIN
TRANSMISSION LINE 230 KV, OTHERS AS NOTED
PUMPING PLANT
POWERPLANT
SUBSTATION
PROJECT HEADQUARTERS
CENTRAL VALLEY BASIN BOUNDARY
WATER SERVICE AREA
UC UNDER CONSTRUCTION
CE CORPS OF ENGINEERS
PACIFIC OCEAN
MALIN-ROUND MTN 500 KV (INTERTIE)
SPRING CREEK TUNNEL
SPRING CR DEBRIS DAM
SHASTA DAM
Shasta Lake
Clair Engle Lake
TRINITY DAM
TRINITY-CARR
Lewiston Lake
LEWISTON DAM
CLEAR CREEK TUNNEL
JUDGE FRANCIS CARR POWERHOUSE
Whiskeytown Lake
CARR-KESWICK NO 1
CARR-KESWICK NO 2
WHISKEYTOWN DAM
CLEAR CREEK SOUTH UNIT
SHASTA-COTTONWOOD
SPRING CR-KESWICK
KESWICK DAM
SHASTA-KESWICK
COW CREEK UNIT
ROUND MTN-COTTONWOOD (INTERTIE)
KESWICK-COTTONWOOD NO 3
KESWICK-COTTONWOOD NO 2
KESWICK-ELVERTA
COTTONWOOD-ELVERTA NO 2
SHASTA-TRACY
COTTONWOOD-TRACY
RED BLUFF DIVERSION DAM
CORNING CANAL
ORLAND PROJECT
BLACK BUTTE LAKE (CE)
STONY CANAL
STONY GORGE
TEHAMA-COLUSA CANAL UC
EAST PARK
COTTONWOOD-ELVERTA NO 3
Lake Oroville (State)
SACRAMENTO RIVER
MARYSVILLE LAKE UC (CE)
SUGAR PINE DAM UC
Lake Tahoe
AUBURN DAM UC
FOLSOM-ELVERTA
Folsom Lake
FOLSOM DAM
SLY PARK DAM
Jenkinson Lake
ELVERTA SWITCHYARD
ELVERTA-HURLEY
MORMON ISLAND PUMPING PLANT
FOLSOM-NIMBUS 115 KV
NIMBUS DAM
COUNTY LINE DAM UC
FOLSOM SOUTH CANAL UC
DELTA CROSS CHANNEL
Lake Berryessa
MONTICELLO DAM
SOLANO PROJECT
HURLEY-TRACY
ELVERTA-TRACY
NEW HOGAN LAKE (CE)
NEW MELONES DAM (CE & USBR) UC
CONTRA COSTA CANAL
TRACY-CONTRA COSTA-YGNACIO 69 KV
TRACY SWITCHYARD
TRACY PUMPING PLANT
NEW DON PEDRO
Lake McClure
SOUTH BAY AQUEDUCT (STATE)
DELTA-MENDOTA CANAL
CALIFORNIA AQUEDUCT (STATE)
SAN LUIS DAM & PUMPING-GENERATING PLANT
& O'NEILL DAM (FEDERAL - STATE)
O'NEILL PUMPING PLANT
SAN FELIPE DIVISION
KESTERSON
HV EASTMAN LAKE (CE)
MADERA CANAL
HIDDEN LAKE (CE)
Millerton Lake
FRIANT DAM
PINE FLAT LAKE (CE)
LOS BANOS DETENTION DAM (FEDERAL-STATE)
DOS AMIGOS PUMPING PLANT (FEDERAL-STATE)
LITTLE PANOCHE DETENTION DAM (FEDERAL-STATE)
SAN LUIS DRAIN UC
SAN LUIS CANAL (FEDERAL - STATE)
Lake Kaweah (CE)
COALINGA CANAL
Tulare Lake
Success Lake (CE)
FRIANT-KERN CANAL
CALIFORNIA AQUEDUCT (STATE)
ISABELLA LAKE (CE)
Buena Vista Lake
TWITCHELL DAM

FIGURE E-6

FACTUAL DATA ON THE CENTRAL VALLEY PROJECT

California's vast Central Valley Project, one of the nation's major water conservation developments, extends from the Cascade Range in the north to the semiarid but fertile plains along the Kern River in the south.

The initial features of the project, authorized by President Roosevelt in 1935 for construction by the Bureau of Reclamation, included:

Shasta Dam on the Sacramento River and Friant Dam on the San Joaquin River to catch and store the floodwaters; Tracy Pumping Plant and Delta-Mendota Canal to transfer Sacramento River water to the San Joaquin Valley; powerplants at Shasta and at Keswick Dam below Shasta, with powerlines to bring the power generated to the Tracy pumps and to integrate that power into other electric systems; the Contra Costa Canal, the Friant-Kern Canal, and the Madera Canal to deliver the water throughout the Central Valley; the Delta Cross Channel to shorten the path of Sacramento River water across the Delta to the Tracy and Contra Costa Pumping Plants. Shasta Dam began storing water in January 1944; by 1951 the project had become fully operational. To help meet the expanding needs in the Central Valley, Congress authorized the American River Division, including Folsom Dam and Powerplant, Nimbus Dam and Powerplant, and the Sly Park Unit, in 1949; the Sacramento Canals Unit in 1950; the Trinity River Division, including Trinity Dam and Powerplant, Lewiston Dam, Whiskeytown Dam, Judge Francis Carr Powerhouse, and Spring Creek Powerplant, in 1955; the San Luis Unit in 1960; the Auburn-Folsom South Unit in 1965; and the San Felipe Division in 1967.

Initial features of the project were primarily built to protect the Central Valley from crippling water shortages and menacing floods. New project units are now being built to provide water and power to match the continued growth of the State, with additional units planned for the future.

Project facilities now in operation, under construction, or authorized, will bring irrigation water to 3,757,000 acres of land, much of which is already under cultivation. In 1969 project powerplants with a total capacity of 1,321,840 kilowatts had been completed and were producing electricity to help meet rapidly growing demands for farm, industrial, and domestic power demands.

Although developed primarily for irrigation, the multiple-purpose Central Valley Project also provides flood control, improves Sacramento River navigation, supplies domestic and industrial water, generates electric power, conserves fish and wildlife, creates opportunities for recreation, repels saline ocean waters from the Sacramento-San Joaquin River Delta, and enhances water quality.

WATER SUPPLY

THE CENTRAL VALLEY BASIN includes two major watersheds—that of the Sacramento River on the north, and the San Joaquin River on the south—plus the Tulare Lake Basin. The combined watersheds extend nearly 500 miles in a northwest-southeast direction and average about 120 miles in width. The basin is surrounded by mountains except for a gap in its western edge, at the Carquinez Straits. The valley floor occupies about one-third of the basin, the other two-thirds are mountainous. The Cascade Range and Sierra Nevada on the north and the east rise in elevation to about 14,000 feet and the Coast Ranges on the west to as high as 8,000 feet. The Sacramento River and its tributaries flow southward draining the northern part of the basin. The San Joaquin River and its tributaries flow northward, draining the central southern portion. The two river systems join at the Sacramento-San Joaquin Delta, flow through Suisun Bay and Carquinez Straits into San Francisco Bay, and thence out the Golden Gate to the Pacific Ocean. The average annual natural runoff of the Central Valley Basin for the 60-year period beginning in water year 1903 was about 33 million acre-feet, and for the critical 7-year dry period 1927 to 1933 inclusive, it was 18 million acre-feet. The average annual historical runoff in acre-feet at four major dams of the Central Valley Project is as follows:

Dam	Stream	50-year average 1910-11 to 1959-60	
Shasta		5,440,000	3,650,000
Eriant		1,670,000	1,040,000
Folsom		2,580,000	1,560,000
Trinity		1,140,000	680,000

PROJECT FACILITIES

TRINITY RIVER DIVISION

The Trinity River Division was completed in 1964. Above Lewiston Dam, Trinity River drains 728 square miles of mountainous country producing a high yield of water. Surplus water from the Trinity River Basin is stored, regulated, and diverted through a system of dams, reservoirs, tunnels and powerplants into the Sacramento River for use in water deficient areas of the Central Valley Basin. Additional power generating capacity is also provided for northern and central California. In addition, Trinity River Division improves recreational opportunities and increases minimum flows in the Trinity River.

Trinity River water is stored in Clair Engle Lake behind Trinity Dam. Releases from this reservoir are utilized to generate power at Trinity and Lewiston Powerplants. Releases from Clair Engle Lake are reregulated in Lewiston Lake 7 miles downstream. Lewiston Dam regulates flows to meet the downstream requirements of the Trinity River Basin, including those of the Trinity River fishery. Water not needed in the Trinity River Basin is diverted by Lewiston Dam through the Clear Creek Tunnel to the Judge Francis Carr Powerhouse and then into Whiskeytown Lake behind Whiskeytown Dam on Clear Creek, a tributary of the Sacramento River. From Whiskeytown Lake the water from Trinity River, and surplus flows from Clear Creek, flow through Spring Creek Tunnel to the Spring Creek Powerplant and discharges into existing Keswick Reservoir on the Sacramento River. Above Keswick Dam, Trinity River water is combined with the Sacramento River, and provides irrigation service to lands in Sacramento Valley and other areas of the Central Valley Project.

TRINITY DAM AND CLAIR ENGLE LAKE on the Trinity River regulates a drainage area of over 700 square miles. Clair Engle Lake stores a maximum of 2,448,000 acre-feet of water. The dam is a zoned earthfill structure 538 feet high with a crest length of 2,450 feet.

TRINITY POWERPLANT at Trinity Dam has two generators with a total capacity of 105,556 kw.

LEWISTON DAM AND LAKE, about 7 miles downstream from Trinity Dam, creates an afterbay to Trinity Powerplant and diverts water by means of Clear Creek Tunnel to Whiskeytown Lake. Lewiston Dam is a zoned earthfill structure 91 feet high with a crest length of 745 feet and forms a reservoir capacity of 14,660 acre-feet.

LEWISTON POWERPLANT, using releases for the support of fish life and other downstream purposes in the Trinity River, has one unit with a capacity of 350 kw.

TRINITY RIVER FISH HATCHERY—The Trinity River is one of California's most famous fishing streams. To maintain the salmon and the steelhead fisheries below Lewiston Dam, 150 cubic feet per second of water is released between December 1 and August 30 of each year. Releases are increased to 200 c.f.s. during the period of September 1 and October 14 and to 250 c.f.s. October 15 to November 14. Releases for the period November 15 to November 30 are set at 200 c.f.s. The higher releases in the fall facilitate natural spawning. The Trinity River Fish Hatchery, with a capacity of about 40 million eggs, is located immediately downstream from Lewiston Dam and compensates for upstream spawning area rendered inaccessible and unusable by the dams.

CLEAR CREEK TUNNEL, 17 1/2 feet in diameter and 10.8 miles long, enables transfer of water from Lewiston Dam to the Judge Francis Carr Powerhouse and Whiskeytown Lake. A bypass is provided into Crystal Creek.

JUDGE FRANCIS CARR POWERHOUSE, located on Clear Creek, has two generators with a capacity of 141,444 kw.

WHISKEYTOWN DAM AND LAKE are located on Clear Creek. The dam provides regulation for Trinity River flows discharged from the Judge Francis Carr Powerhouse and regulates the runoff from the Clear Creek drainage area. The dam is a zoned earthfill structure 282 feet high, with a main crest length of 2,280 feet, and creates a reservoir with a capacity of 241,100 acre-feet.

SPRING CREEK TUNNEL AND POWERPLANT. The tunnel diverts water from Whiskeytown Lake on Clear Creek, a tributary of the Sacramento River, to the Spring Creek Powerplant. The tunnel is 18 1/2 feet in diameter and about 3 miles in length, including the 17-foot-diameter Rock Creek Siphon, six-tenths of a mile in length. It has two generators with a capacity of 150,000 kw.

SPRING CREEK DEBRIS DAM AND RESERVOIR. The dam is a zoned earthfill structure 196 feet high with a crest length of 1,140 feet, located on Spring Creek above the powerplant tailrace. The reservoir, with a capacity of 5,800 acre-feet, controls debris which would otherwise enter the powerplant tailrace, and provides important fishery benefits by controlling contaminated runoff resulting from old mine tailings on Spring Creek.

CLEAR CREEK SOUTH UNIT, located in Shasta County, was authorized as a part of the Trinity River Division. The major feature is the 11.7-mile-long Whiskeytown Conduit with capacity to transport 15,000 acre-feet of water from the Whiskeytown Lake for agricultural and municipal and industrial use in the Clear Creek Community Service District of Anderson.

COW CREEK UNIT, located in Shasta County, was authorized as a part of the Trinity River Division in 1955. The unit features consist of Wintu Pumping Plant with a maximum capacity of 100 c.f.s., 92 c.f.s., through the main conveyance, and a pressure system with branching pressure distribution lines. About 23,000 acre-feet of water can be lifted 295 feet from the Sacramento River by the Wintu Pumping Plant, into the 8-mile-long Bella Vista Conduit for agricultural and municipal and industrial use on land east of Redding.

SHASTA DIVISION

SHASTA DAM AND SHASTA LAKE on the Sacramento River have a drainage area of 6,665 square miles and store a maximum of 4,552,000 acre-feet of water. Floods are controlled and surplus winter runoff is stored. The dam is a curved concrete gravity structure, with a height of 602 feet and a crest length of 3,460 feet.

SHASTA POWERPLANT is located just below Shasta Dam. Water from the dam is released through five 15-foot-diameter penstocks leading to the five main generating units and two station service units. The total capacity of these units is 422, 310 kw.

KESWICK DAM AND POWERPLANT are located on the Sacramento River 9 miles downstream from Shasta Dam. The dam creates an afterbay for Shasta Lake and Trinity River Division and smooths out the uneven water releases from the powerplants.

Migratory fish trapping facilities at the dam are operated in conjunction with the Coleman Fish Hatchery on Battle Creek, 25 miles downstream. Keswick Dam is a concrete gravity structure 159 feet high with a crest length of 1,046 feet. The powerplants has three generating units with a total capacity of 75,000 kw.

SACRAMENTO RIVER DIVISION

SACRAMENTO CANALS UNIT consists of the Red Bluff Diversion Dam, Corning Pumping Plant, and three main canals. The unit was authorized to supply irrigation water to over 200,000 acres in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo Counties.

RED BLUEE DIVERSION DAM diverts water from the Sacramento River to the Corning Canal and the Tehama-Colusa Canal service areas. The structure is cnncrete, 78 feet high, 752 feet long with earth wings. Eish ladders at each abutment permit king salmon and steelhead to pass around the dam in their migration to spawning areas.

CORNING CANAL diverts water from the Tehama-Colusa Canal about 1/2 mile downstream of the Red Bluff Diversion Dam. The water is lifted 56 feet at the Corning Pumping Plant and is delivered to lands in Tehama County with an elevation too high to be served from Tehama-Colusa Canal. The canal is 21 miles long and terminates about 4 miles southwest of Corning. The initial diversion capacity is 500 c.f.s. which is gradually decreased to 88 c.f.s. at the terminus.

TEHAMA-COLUSA CANAL is presently under construction. The first reach of the canal, which extends southerly from Red Bluff Diversion Dam, has a multipurpose function. Included in the upper end of the canal are the Tehama-Colusa Fish Facilities, which provide 1.6 million square feet of spawning area for salmon in special gravel bottomed portions of the canal. These facilities are the largest of their kind in the world. A new cycle of Tehama-Colusa salmon are expected to start an annual migration back to these spawning beds by 1975. When completed, the canal will be approximately 122 miles long and will serve irrigation needs in Tehama, Glenn, Colusa and northern Yolo Counties. The initial diversion capacity is 2,300 c.f.s.

STONY CANAL is authorized but not under construction. It would divert water from Black Butte Reservoir southeasterly to serve areas west of the Orland Project. The canal would be approximately 23 miles long. The initial diversion capacity would be 225 c.f.s.

AMERICAN RIVER DIVISION

FOLSOM UNIT consists of Folsom Dam, Lake, and Powerplant, Nimbus Dam, Lake Natoma, and Nimbus Powerplant on the American River.

FOLSOM DAM AND FOLSOM LAKE. Folsom Dam, below a drainage area of 1,875 square miles, was constructed by the Corps of Engineers and upon completion was turned over to the Bureau of Reclamation for coordinated operation with other Central Valley Project structures. The dam has a concrete main river section having a height of 340 feet and a crest length of 1,400 feet, flanked by long earthfill wing dams extending from the ends of the concrete section on both abutments for a total length of 10,200 feet. The dam plus an earthfill auxiliary dam at Mormon Island saddle and eight other earthfill dikes create Eolsom Lake with a storage capacity of 1,010,000 acre-feet. The dam regulates flows of the American River for irrigation, power, flood control, municipal and industrial use, fish and wildlife, recreation, and other purposes.

FOLSOM POWERPLANT, constructed and operated by the Bureau of Reclamation, is located just below Folsom Dam. Water from the dam is released through three 15-foot-diameter penstocks to three generating units. The total capacity is 186,480 kw.

NIMBUS DAM AND POWERPLANT, AND LAKE NATOMA. Nimbus Dam, 7 miles below Folsom, creates Lake Natoma to reregulate the releases for power made through Folsom Powerplant. The dam is a concrete gravity structure, 76 feet in height, with a crest length of 1,093 feet. It serves as a diversion dam for the Folsom South Canal. The 13,500 kw. two-unit powerplant is located at the toe of Nimbus Dam. Also located at Nimbus Dam is the 30 million egg Nimbus Fish Hatchery.

SLY PARK UNIT includes Jenkinson Lake formed by Sly Park Dam on Sly Park Creek, a low concrete diversion dam on Camp Creek, and the Sly Park-Camino Conduit. Sly Park Dam is an earthfill structure 190 feet high with a crest length of 760 feet, and with an auxiliary earthfill dam 130 feet high with a crest length of 600 feet. Jenkinson Lake has a storage capacity of 41,000 acre-feet. The concrete diversion dam on Camp Creek and connecting tunnel from Camp Creek to Sly Park Creek augment the inflow into Jenkinson Lake. Sly Park-Camino Conduit, with a capacity of 125 c.f.s., extends 7 miles west from Sly Park Dam to Camino to deliver supplemental water to El Dorado Irrigation District for irrigation and municipal purposes in the vicinity of Placerville.

AUBURN-FOLSOM SOUTH UNIT will consist of 3 dams, 1 canal, 1 powerplant, 3 pumping plants and necessary diversion works, conduits, and appurtenant works for the delivery of water supplies in Placer, El Dorado, Sacramento, and San Joaquin Counties, and for future needs of the project. The unit will also provide hydroelectric power, flood control, fish protection, and new recreational facilities.

AUBURN DAM presently under construction will be a 700-foot-high, concrete thin arch structure, with a crest length of 4,000 feet. The dam will create the 2.4 million acre-foot Auburn Reservoir. The reservoir will control the varying flows of the North and Middle Forks of the American River. Releases from the reservoir will flow through Auburn and Folsom Powerplants and supply the Folsom South Canal. Auburn Powerplant will have an initial installed capacity of 300,000 kw. with a potential capacity of 750,000 kw. Water from Sugar Pine Reservoir on North Shirttail Canyon Creek will be piped to the Foresthill Divide service area for irrigation, municipal and industrial use. County Line Reservoir on Deer Creek would operate in conjunction with pumping from Folsom Lake to provide water service in the Folsom-Malby area for municipal and industrial use, and for distribution by local interests.

EOLSOM SOUTH CANAL is presently under construction. The canal nriginates at Lake Natoma, which is an afterbay of Folsom Dam. When completed, the canal will be approximately 69 miles long and serve industrial, municipal, and irrigation users in Sacramento and San Joaquin Counties. The initial diversion capacity is 3,500 c.f.s.

DELTA DIVISION

DELTA CROSS CHANNEL is a controlled diversion channel between the Sacramento River and Snodgrass Slough. Water is diverted from the river through a short excavated channel near Walnut Grove into the slough. It then flows through natural channels for about 50 miles to the vicinity of the Tracy Pumping Plant. The diversion provides an adequate supply of water to the intakes of the Contra Costa and the Delta-Mendota Canals, improves the irrigation supplies in the Sacramento-San Joaquin Delta and helps repel ocean salinity. The channel is designed to divert approximately 3,500 c.f.s.

CONTRA COSTA CANAL originates at Rock Slough about 4 miles southeast of Oakley, where it intercepts natural flow in the Sacramento-San Joaquin Delta. Water for municipal, industrial and irrigation use is lifted 127 feet by a series of four pumping plants. The canal is 47.6 miles long and terminates in the Martinez Reservoir. The initial diversion capacity is 350 c.f.s. which gradually decreases to 22 c.f.s. at the terminus.

TRACY PUMPING PLANT consists of an inlet channel, pumping plant, and discharge pipes. Water in the Delta released from storage in Shasta, Clair Engle, and Folsom Lakes or entering the Sacramento River system below those reservoirs is lifted 197 feet into the Delta-Mendota Canal. Each of the six pumps at Tracy is powered by a 22,500 horsepower electric motor and is capable of pumping at the rate of 767 c.f.s. Power to run the huge pumps is supplied by Central Valley Project powerplants. The water is pumped through three 15-foot-diameter discharge pipes which carry it about 1 mile up an inclined grade to the Delta-Mendota Canal. The intake canal includes the Tracy Fish Screen which was built to intercept downstream migrant fish so they may be returned to the main channel to resume their journey to the ocean.

DELTA-MENDOTA CANAL carries water southeasterly from the Tracy Pumping Plant along the west side of the San Joaquin Valley for irrigation supply, use in the San Luis Unit, and to replace San Joaquin River water stored by Friant Dam and used in the Friant-Kern and Madera systems. The canal is 113 miles long and terminates at the Mendota Pool about 30 miles west of Fresno. The initial diversion capacity is 4,600 c.f.s. which is gradually decreased to 3,211 c.f.s. at the terminus.

WEST SAN JOAQUIN DIVISION

THE SAN LUIS UNIT, latest link in the Central Valley Project and also the State of California Water Plan, was authorized to be built and operated jointly with the State of California. The San Luis Unit consists of one major dam and reservoir, a forebay dam and forebay, two detention dams and reservoirs, two pumping plants, two pumping-generating plants, two major canals, and switchyard facilities.

SAN LUIS DAM AND RESERVOIR (JOINT FEDERAL-STATE FACILITIES) are located on San Luis Creek near Los Banos. The reservoir with a capacity of 2,041,000 acre-feet is used to store surplus water of the Sacramento-San Joaquin Delta. Releases are made through the San Luis Pumping-Generating Plant, utilizing its generating capability to generate power. The dam is a zoned earthfill structure, 382 feet high, with a crest length of 18,600 feet.

O'NEILL DAM AND FOREBAY (JOINT FEDERAL-STATE FACILITIES) are located on San Luis Creek 2 1/2 miles downstream from San Luis Dam. O'Neill Dam is a zoned earthfill structure with a height of 87 feet and a crest length of 14,300 feet; the Forebay has a capacity of 56,400 acre-feet. The Eorebay is utilized as a hydraulic junction point for Eederal and State waters, the top 8 feet (or 20,000 acre-feet) acting as a reregulator storage necessary to permit offpeak pumping and onpeak generation by the main San Luis Pumping-Generating Plant. Recreation facilities are provided on the Forebay.

O'NEILL PUMPING PLANT (FEDERAL FACILITY) consists of an intake channel leading off the Delta-Mendota Canal, 70 miles from the Tracy Pumping Plant, and six pumping-generating units. Normally these units operate as pumps to lift water from 45 to 53 feet into the O'Neill Forebay. When water is occasionly released from the Forebay to the Delta-Mendota Canal, these units operate as generators. When operating as pumps and motors each unit can discharge 700 c.f.s. and has a rating of 6,000 hp. When operating as turbines and generators, each unit will have a generating capacity of about 4,200 kw.

SAN LUIS PUMPING-GENERATING PLANT (JOINT FEDERAL-STATE FACILITY), located at San Luis Dam, lifts water by pump-turbines from the O'Neill Forebay into San Luis Reservoir. During the irrigation season, water is released from San Luis Reservoir back through the pump-turbines to the Forebay and energy is reclaimed. Each of the eight pumping-generating units has a capacity of 63,000 hp. as a motor and 53,000 kw. as a generator. As a pumping station to fill San Luis Reservoir, each unit lifts 1,375 c.f.s at 290 feet total head. As a generating plant, each unit passes 1,640 c.f.s. at the same head.

SAN LUIS CANAL (JOINT FEDERAL-STATE FACILITY) is a concrete-lined canal 102 miles long, with a capacity ranging from 13,100 to 8,350 c.f.s.

DOS AMIGOS PUMPING PLANT (JOINT EEDERAL-STATE FACILITY), 17 miles south of the Eorebay, is a relift plant in the San Luis Canal. The plant contains six pumping units, each capable of delivering 2,200 c.f.s. at 125 feet of head.

COALINGA CANAL (FEDERAL FACILITY) is a concrete-lined canal 11.6 miles in length with a capacity of 1,110 c.f.s.

PLEASANT VALLEY PUMPING PLANT (FEDERAL FACILITY) will lift water 180 feet from an intake channel leading from San Luis Canal at mile 74. Three 7,000-, three 3,500-, and three 1,250-hp. units will be used to deliver 1,140 c.f.s. into Coalinga Canal.

LOS BANOS AND LITTLE PANOCHE DETENTION DAMS AND LOS BANOS AND LITTLE PANOCHE RESERVOIRS (JOINT EEDERAL-STATE FACILITIES) are features required to protect the San Luis Canal by controlling flows of streams crossing the canal.

SAN LUIS DRAIN (FEDERAL FACILITY) now under construction, will be a concrete-lined canal extending 188 miles from the vicinity of Kettleman City to the lower San Joaquin-Sacramento Delta. The drain will convey and dispose of irrigation return flows from the San Luis service area.

FRIANT DIVISION

FRIANT DAM AND MILLERTON LAKE are located on the San Joaquin River, below a drainage area of 1,630 square miles. Friant Dam is a straight concrete gravity-type structure 319 feet high with a crest length of 3,488 feet. The reservoir has a capacity of 520,500 acre-feet. It controls San Joaquin River flows, provides downstream releases to meet requirements above Mendota Pool, and provides conservation storage and diversion into Madera and Friant-Kern Canals.

MADERA CANAL carries water northerly from Millerton Lake to furnish new and supplemental supplies to lands in Madera County. The canal has a diversion capacity of 1,000 c.f.s., is 36 miles long, with a maximum bottom width of 20 feet and a water depth of over 9 feet.

FRIANT-KERN CANAL carries water from Millerton Lake southerly for supplemental and new irrigation supplies in Fresno, Tulare, and Kern Counties. The canal has a capacity of 4,000 c.f.s. from Friant Dam to the Kaweah River. The canal, 152 miles long, terminates in the Kern River about 4 miles west of Bakersfield.

SAN FELIPE DIVISION (Authorized for Construction)

THE SAN FELIPE DIVISION includes Pacheco Tunnel, which will be about 10 miles long, with 104 miles of conveyance facilities, pumping plants, power transmission facilities, regulator reservoirs, and distribution facilities. An average of 293,000 acre-feet of water will be delivered annually from Central Valley Project Sources through San Luis Reservoir and Pacheco Tunnel.

ELECTRICAL TRANSMISSION SYSTEM

THE TRANSMISSION SYSTEM consists of switchyards, high voltage lines, and substations for delivery of power to project pumps and for wholesale disposal of excess power with approximately 1,144 circuit-miles of 230-kv line. The backbone of the system consists of two 230-kv circuits from the Shasta-Trinity Powerplant complex to Tracy Switchyard, three 230-kv circuits from the Shasta-Trinity Powerplant complex to Elverta Substation, two 230-kv circuits from Elverta Substation Tracy Switchyard, plus a 230-kv connection between Folsom Powerplant and Elverta Substation. The system is connected to the Northwest by the Malin-Round Mountain 500-kv line and the Round Mountain-Cottonwood 230-kv line, both units of the Pacific Northwest-Pacific Southwest Intertie.

CORPS OF ENGINEERS PROJECTS

Buchanan and Hidden Dams and Reservoirs, and Marysville Dam, Powerplant, and Reservoir, are authorized for construction and operation by the Corps of Engineers. The projects will be financially integrated with the Central Valley Project with the Bureau of Reclamation authorized to sell the water and the power. New Melones Dam, Powerplant, and Reservoir are authorized for construction by the Corps of Engineers. The Bureau will integrate, operate, and maintain New Melones as a unit of Central Valley Project.

IRRIGATION PLAN

Reservoirs of the Central Valley Project are coordinated in their operation in order to obtain maximum yields and to deliver water into the main river channels and into the canals of the project in the most efficient and economical manner. Irrigation and municipal water is delivered from the main canals in accordance with long-term contracts negotiated with irrigation districts and other local organizations. The distribution of water from the main canals to the individual users is the responsibility of the local districts.

IRRIGATION DISTRIBUTION SYSTEMS consist of lateral canals and pipe systems to take water from the main canals and deliver it to individual farms. The Bureau of Reclamation has built several distribution systems and is constructing others for the water users.

IRRIGABLE ACRES IN THE PROJECT

The irrigable acreage of the service area of the authorized Central Valley Project is approximately 3,757,000 acres. A full irrigation water supply is furnished to new lands and a supplemental supply for presently irrigated areas.

CHARACTER OF SOIL IN IRRIGABLE AREAS

Approximately two-thirds of the soils in the project service area are recent alluvial deposits suitable for a wide variety of crops. The remainder of the alluvial soils have moderately compacted subsoils which somewhat limit crop adaptability and types of farming. Residual soils of variable depths are found in the small areas of the foothill lands.

ALTITUDE OF IRRIGABLE AREA

The irrigable lands are below elevations of 500 feet, except for the Sly Park Unit with an elevation of around 2,500 feet in the foothills.

FARM WATER REQUIREMENT

The farm irrigation water requirement varies to some extent climatologically but principally by crop and soil types. Under good irrigation practices, the water requirement varies from as little as 1 acre-foot per acre for grain to as much as 7 acre-feet per acre for rice. The farm water use for the Central Valley Project averages around 3 acre-feet per acre.

LENGTH OF IRRIGATION

The irrigation season extends over a period of time of from 6 to 10 months. The total growing season averages over 240 days.

ANNUAL RAINFALL

Precipitation throughout the Central Valley varies geographically, seasonally, and annually. On the main valley floor, rainfall is comparatively light, decreasing from an annual normal of 22 inches at Red Bluff to 6 inches at Bakersfield.

On the east side of the valley is the Cascade Range and Sierra Nevada, the precipitation varies from a normal annual of 80 inches in the north to 35 inches in the south, most of which falls as snow above the 3,100- to 6,400-foot elevation. In the Coast Range precipitation is less than in the Cascade Range and Sierra Nevada and falls almost entirely as rain. Precipitation varies in the amount from year to year, the maximum some 3.5 times the minimum, with extremes at more than 7 times the minimum.

RANGE OF TEMPERATURE

The main valley floor has warm dry summers with occasional temperatures exceeding 100°F., and mild winters with minimum temperatures rarely below 32°F. In the summer, surrounding mountains are generally warm and dry but in the winter, particularly in the Cascade Range and Sierra Nevada, temperatures drop below freezing.

The average annual temperature for Sacramento is about 60° and for Fresno about 63°. The average frost-free period in the valley is about 9 months, the winter months are mild with an average of less than 15 days when minimum temperatures are below 32°.

PRINCIPAL PRODUCTS

Of the 220 different crops grown on Central Valley farms, the principal ones are field crops—including alfalfa, irrigated pasture, sugar beets, beans, barley, cotton, and rice; truck crops—including asparagus, potatoes, tomatoes, melons, and a variety of other vegetables; fruit and nuts—including grapes, peaches, plums, prunes, apricots, pears, olives, oranges, almonds, and walnuts. Seed crops—truck and pasture—are raised extensively. Practically all of these crops except for some barley, almonds, and beans are grown under irrigation, with 90 percent of the gross farm income of the Central Valley Basin from irrigated crops. The production of livestock for beef and for dairy products is also very important in the Central Valley.

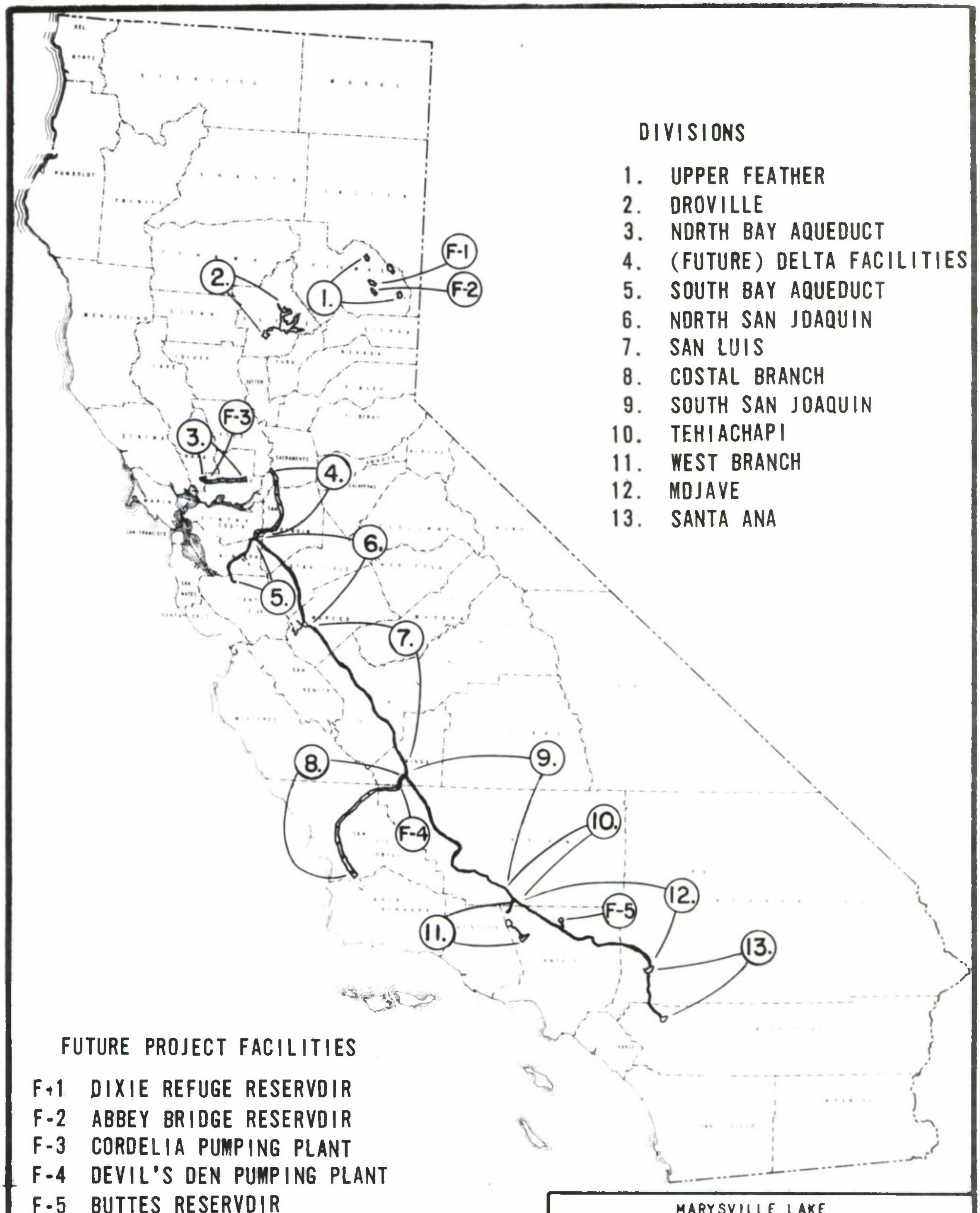
PRINCIPAL MARKETS

The Central Valley crops enjoy a wide distribution and are shipped to all major national and many international markets. Livestock, dairy products, and basic field crops are primarily marketed locally as these markets are increasing as a result of substantial population growth.

Address all inquiries regarding additional information concerning this project to:

REGIONAL DIRECTOR
MID-PACIFIC REGION
BUREAU OF RECLAMATION
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

GPO 792-397



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

STATE WATER PLAN

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: K.L.
Date: FEB. 1977

FIGURE F-7

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX F
HYDROLOGY, HYDRAULICS,
AND RESERVOIR REGULATION

APPENDIX F - HYDROLOGY, HYDRAULICS, AND RESERVOIR REGULATION

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APPENDIX F - HYDROLOGY, HYDRAULICS,
AND RESERVOIR REGULATION

1. General. -

Design Memorandum No. 2, Hydrology, approved by OCE 27 June 1972, contains basic hydrologic data, describes development of the standard project flood, the spillway design flood, freeboard criteria, wave action, and other hydrologic information for a 968,000 acre-foot project at the Browns Valley site. The site has been changed to Parks Bar, with storage of 916,000 acre-feet; however, these changes had little effect on the basic hydrologic data presented in Design Memorandum No. 2. Variances in data presented in Design Memorandum No. 2 as a result of these changes and recent studies are described in this appendix.

2. Topographic features. -

The Yuba River drains a portion of the western slope of the Sierra Nevada in North Central California. The drainage area is 1,350 square miles at the mouth and 1,296 square miles at the Marysville (Parks Bar) damsite. The basin ranges in elevation from 60 feet msl at its mouth to a maximum of 9,000 feet msl. The mountain portion of the basin is drained by the North, Middle and South Yuba Rivers which flow in deep parallel canyons. These tributaries join above the Marysville damsite to form the main stem Yuba River which flows across the valley floor and is tributary to the Feather River near the city of Marysville. A general map of the basin is presented in Figure F-1.

3. Precipitation. -

Normal precipitation varies widely across the Yuba River basin, ranging from a low of about 20 inches on the valley floor to over 90 inches at higher elevations. Normal monthly and annual precipitation amounts for three stations typical of the basin are given in the following tabulation:

Month	Marysville Elev. 62 ft.		Camptonville R. S. Elev. 2,755 ft.		Bowman Dam Elev. 5,347 ft.	
	Inches	%	Inches	%	Inches	%
Jul	.01	0.1	.03	0.1	.16	0.2
Aug	.02	0.1	.04	0.1	.13	0.2
Sep	.23	1.1	.57	1.0	.74	1.1
Oct	1.13	5.5	3.39	5.7	3.83	5.8
Nov	2.03	9.9	6.36	10.6	6.62	10.0
Dec	3.88	18.8	10.63	17.8	10.82	16.3
Jan	3.99	19.4	11.63	19.4	12.48	18.8
Feb	3.86	18.7	10.06	16.8	11.45	17.3
Mar	2.68	13.0	8.42	14.1	10.13	15.3
Apr	1.74	8.4	4.95	8.3	5.15	7.8
May	.80	3.9	2.91	4.8	3.61	5.4
Jun	.22	1.1	.77	1.3	1.23	1.8
Total	20.59	100.0	59.76	100.0	66.35	100.0

The greater part of the precipitation occurs from October through April, with maximum amounts during December, January, February, and March. A large portion of the precipitation in the Yuba River watershed falls in the form of snow in the winter and melts during the spring and early summer. Typical flood producing storms may last for several days and are generally composed of a rapid succession of several individual storms which combine to produce high intensity peak flows on all streams in the basins.

4. Streamflow. -

Streamflow records are available for 10 US Geological Survey stream gaging stations located within the Yuba River basin. The annual unimpaired (full natural) runoff of the Yuba River below Smartville, including Deer and Dry Creeks averages 2,274,000 acre-feet and has ranged from a maximum of 4,544,000 acre-feet in water year 1907 to a minimum of 603,000 acre-feet in water year 1924. The annual impaired runoff at Marysville averages 1,850,000 acre-feet. Natural streamflow conditions of the Yuba River have been modified by small storage reservoirs, numerous power canals, and diversions for irrigation. These regulatory units reduce peak flows, change the monthly distribution of runoff, and reduce the annual volume reaching the Marysville gage. These effects are apparent during low flow periods, but major storm runoff is not appreciably affected by these upstream regulations. Average monthly runoff at the Marysville gaging station for the period 1944 through 1969 is summarized below:

Month	Flow 1,000 acre-feet
Oct	28
Nov	58
Dec	120
Jan	203
Feb	241
Mar	277
Apr	318
May	328
Jun	176
Jul	61
Aug	22
Sep	18
Total	1,850

5. Flood characteristics. -

Snowmelt floods are not a problem in the Yuba River basin because channel capacities far exceed maximum snowmelt runoff rates. Maximum floodflows occur between the months of November and April and are the result of direct runoff from intense rainfall, which may be augmented by melting snow. The largest recorded flood discharge on the Yuba River at the Marysville gage occurred in December 1964 with a peak flow of 180,000 cfs. This storm also produced the largest recorded flood discharge for the North Yuba River at Bullards Bar Dam where the peak flow was 91,700 cfs. The Yuba River basin has experienced relatively frequent flooding during the last 150 years. The estimated and observed peaks and volumes for several recent major floods are shown in the next tabulation.

Location	Date of flood	Peak flow cfs	120-hour volume inches	120-hour volume acre-feet
North Yuba River below New Bullards Bar Dam	Nov 1950	47,000	8.24	213,900
	Dec 1955	87,000 Est.	13.23	343,400
	Oct 1962	39,500 Est.	4.87	126,400
	Feb 1963	83,000 Est.	7.64	198,300
	Dec 1964	91,600	13.94	362,000
	Jan 1970	56,000	11.85	309,400
Yuba River at Englebright Dam	Nov 1950	109,000	7.27	430,100
	Dec 1955	148,000	10.53	619,500
	Oct 1962	91,700	4.33	254,800
	Feb 1963	150,000	7.24	426,000
	Dec 1964	171,000	13.48	797,000
	Jan 1970	94,000	8.33	492,000
Yuba River at Marysville	Nov 1950	78,800	5.32	380,000
	Dec 1955	160,000	9.70	692,000
	Oct 1962	-	-	-
	Feb 1963	146,000	5.97	426,400
	Dec 1964	180,000	11.59	818,000
	Jan 1970	106,000	7.72	551,000

6. Flood plain. -

The Yuba River enters the Feather River flood plain below Daguerre Point Dam. The flood plain, which is the area that has been or is susceptible to flooding by the Feather River and its tributaries, is estimated to encompass 337,000 acres and extends from where the Feather River leaves the Sierra foothills at Oroville to its confluence with the Sacramento River at Verona, 66 miles downstream. The Yuba River joins the Feather River at Marysville, 28 miles above its confluence with the Sacramento River. Although existing land use is primarily agricultural, about 40 percent of the total population of Yuba, Sutter, and Butte Counties is situated in the flood plain. The main urban centers--Marysville, Yuba City, part of Oroville, Linda, Olivehurst, Biggs, Gridley, and Live Oak--are located in the flood plain.

Most of the flood plain of the Feather and Yuba Rivers is protected by levees constructed or improved by the Corps of Engineers as part of the Sacramento River Flood Control Project; these levees have a minimum of 3 feet of freeboard at the design flow. There is an unprotected area of flood plain on the left bank of the Feather River upstream of Honcut Creek. There is also an unprotected area where Jack and Simmerly Sloughs join the Feather River; floodwater backs up these sloughs and spills over onto the surrounding land. The rest of the Feather River floodway is confined between project levees. The levee design capacity for each flood reach in the Feather River floodway is shown in the next tabulation.

Reach	Design Capacity, cfs
Feather River above Yuba River	210,000
Feather River below Yuba River	300,000
Feather River at mouth	320,000

The Yuba River floodway is confined by levees on both banks, but the area between the levees is quite extensive except at Marysville. Marysville itself is protected by a high ring levee. The floodway capacity in the lower 4-1/2 miles of the Yuba River is affected by backwater from the Feather River and is 120,000 cfs under conditions of high flow in the Feather River.

Under present conditions, Yuba River flows exceed design levee capacity (except the Marysville ring levee) about once in 70 years on the average, and high flows in the Feather River below the Yuba River exceed design levee capacity about once in 200 years. In the upstream tributary areas, runoff accumulates rapidly, and the floods produced are of high intensity, but of relatively short duration. Flood velocities are high, and damages to roads, bridges, and improvements along the rivers are severe. In the lower stream reaches, velocities decrease with the decrease in stream gradient.

7. Flood conditions. -

The most destructive flood of record on the Yuba River occurred in the 20-day period between 21 November and 10 December 1950. The flood peak of

21 November caused a break along the south bank of the Yuba River near Hammonton, with widespread flooding extending west to the east levee of the Feather River and south to the Bear River. About 43,200 acres were inundated, including 18,000 acres west of Highway 70. The total loss due to this flood was over $4 million, of which $3,620,000 was below Harry L. Englebright Dam.

The most destructive flood on the Feather River occurred in December 1955, before the construction of Oroville or New Bullards Bar Dams. The maximum floodflows occurred at about the same time on the Feather and Yuba Rivers. This flood inundated about 100,000 acres, including 2,000 acres in Yuba City. The remainder of the flooding was on developed agricultural land, including suburban, commercial, and industrial developments. The flood caused the evacuation of about 30,000 people, flooded 3,300 homes, disrupted normal community activities for several months, drowned 6,000 head of livestock, and caused the loss of 38 human lives. Damage totalled in excess of $50 million.

The peak flow at the Oroville Dam site in 1964 exceeded the 1955 peak flow; however, the partially completed Oroville Dam reduced the peak to less than the 1955 peak, preventing an estimated $30,000,000 in damages considering levee failure probabilities or $1,800,000 without levee failure. Other large floods occurred in 1907, 1909, 1928, 1937, 1940, and 1942.

Information on peak flows and volumes of recent major floods for the Yuba River are presented in the tabulation in paragraph 5.

The most critical flood situation in the Marysville-Yuba City area would occur when there is a flood of the magnitude of the standard project flood on the Yuba River concurrently with high flows in the Feather River. When the Feather River flow at Yuba City is high, the combined flow of the Yuba and Feather Rivers may also exceed the capacity of the lower Feather River floodway. For these reasons the flood protection system for the Feather-Yuba Rivers flood plain is managed as a single system.

Flooding in the Marysville-Yuba City area is affected by the operation of two reservoirs for flood control: Oroville Dam on the Feather River, with 750,000 acre-feet of flood storage reservation, and New Bullards Bar Dam on the North Yuba River, with a flood storage reservation of 170,000 acre-feet. These reservoirs are operated for flood control under an interim coordinated operating procedure. Because Oroville Dam outflows are reduced when coincident high flows in the Yuba River are anticipated, the SPF cannot be controlled at Oroville Reservoir. New Bullards Bar Dam controls runoff from only 36 percent (487 sq. miles) of the Yuba River basin drainage area and has no control over flows in the Middle and South Yuba Rivers. It is, therefore, operated to delay the peak flows on the North Yuba River until the peak flows on the other

tributaries have passed through the lower Yuba River. The New Bullards Bar design operating procedure limits outflows, insofar as possible, to those not causing flows in the Yuba River at Marysville to exceed 120,000 cfs; however, the location of New Bullards Bar Dam is such that it cannot confine flows in the lower Yuba and Feather Rivers to nondamaging rates under severe flood conditions.

8. Downstream channel capacities. -

The flow that can be safely conveyed in the Yuba River downstream from the Marysville Lake depends on the condition of the levees and channel and the backwater effect from coincident flow in the Feather River. The Yuba River levees have a design capacity of 120,000 cfs with high Feather River backwater conditions. (Levees of the Sacramento River Flood Control Project are designed to have a minimum of 3 feet of freeboard at the design flow.)

The December 1955 flood, which had a peak flow in the Yuba River of 160,000 cfs at the Marysville gage, concurrent with high stages and subsequent levee failure on the Feather River, did not cause failure of Yuba River levees, but did encroach into the levee freeboard. In December 1964 the Yuba River at Marysville had a peak flow of 180,000 cfs at a time when stages in the Feather River were low, and this flood peak was passed without encroachment into design freeboard. In addition to the difference in stages for these two floods due to the difference in concurrent Feather River flows, there was a difference in stage due to clearing of the Feather River channel below the Yuba River

following the 1955 flood. Also, in 1964 there was some delay in Feather River flows reaching the Yuba River due to detention of Feather River floodflows in the then partially completed Oroville Dam.

Levee design capacities, which are the maximum nondamaging flows that can be conveyed by the levee systems, are shown in the following tabulation.

Reach	Design Capacity, cfs
Yuba River at mouth	120,000
Feather River above Yuba River	210,000
Feather River below Yuba River	300,000
Feather River at mouth	320,000

9. Project design floods. -

a. Standard project flood. - The approved standard project flood for the Yuba River at Marysville damsite has a peak flow of 230,000 cfs and a 5-day volume of 957,000 acre-feet. A flood operation for routing this flood through Marysville Lake is shown on Figure F-2. The peak outflow resulting from the flood routing is 120,000 cfs with a maximum pool elevation of 559.7 feet msl. This routing reflects the combined system operation of Oroville, Marysville, and New Bullards Bar lakes.

b. Spillway design flood. - A synthetic flood based on a 72-hour

probable maximum precipitation of 33.03 inches augmented by 5.86 inches of water equivalent snowmelt was used for spillway design purposes. The resultant flood hydrograph has a peak inflow of 460,000 cfs and a 5-day volume of 1,904,000 acre-feet. A preliminary routing of this flood through the reservoir gave a peak outflow of 460,000 cfs and a maximum storage of 950,000 acre-feet. Hydrographs of inflow, outflow, and reservoir storage are shown on Figure F-3.

10. Flood frequency. -

Flow frequency curves were developed for Yuba River at mouth, Feather River below mouth of Yuba River, Feather River at mouth, and Feather River below Oroville Dam; they are shown on Figures F-4, F-5, F-6, and F-7, respectively. For each index point, curves for three conditions were developed as follows: (a) unregulated and confined by levees; (b) present conditions (with New Bullards Bar and Oroville Reservoirs operating for flood control); and (c) project conditions (with New Bullards Bar, Oroville, and Marysville Reservoirs operating for flood control). In addition, curves for Feather River were developed with and without levee breaks on Yuba River.

11. Flood control space and operation. -

a. Previous space determinations. - Preauthorization investigations indicated that 400,000 acre-feet of main-stem flood control storage space on the Yuba River was required to control the standard project flood. A

main-stem equivalent space of 140,000 acre-feet is provided by the 170,000 acre-feet flood control space in New Bullards Bar Lake, with the remaining 260,000 acre-feet of flood control space to be included in the Marysville Lake project. Results of a subsequent study were presented in Design Memorandum No. 2, "Hydrology," revised April 1971. In DM No. 2, floods resulting from the standard project storm occurring on wet ground and on dry ground were routed through the New Bullards Bar-Marysville (Browns Valley site) system. Essentially no Yuba-Feather River coordinated system operation was considered at that time, and all of the routings were based on coincident flows in the Feather River which limited the objective flow in the Yuba River to 120,000 cfs. Additionally, achievement of optimum objective releases was assumed to average 80 percent. The routings indicated 242,000 acre-feet and 166,000 acre-feet of flood control reservation would be required in Marysville Lake to control a standard project storm under wet and dry ground conditions, respectively. It should be noted that the Marysville preliminary flood control diagram required that, with antecedent wet ground conditions, the full flood control reservation be available at the beginning of the standard project flood. However, with dry ground conditions, only 160,000 acre-feet of flood control reservation was required at the start of the flood, resulting in the maximum pool elevation slightly exceeding the top of the flood pool.

b. Current space determinations. - In order to obtain standard project flood protection within the combined Feather-Yuba River basin, it is necessary to coordinate flood control operation of Oroville, Marysville, and New

Bullards Bar Lakes. Consequently, a coordinated system analysis of these three impoundments was considered necessary to provide a logical approach to the determination of the flood control reservation for Marysville Lake. The HEC-5 computer program "Reservoir System Operation for Flood Control" was used to evaluate the standard project flood requirements in the combined Feather-Yuba basin. The HEC-5 program uses a method of index levels for each reservoir to determine priority of releases to keep in the system in balance, if possible. (A system is considered "in balance" when all the reservoirs are at the same index level.) The system study showed that 240,000 acre-feet of flood space would be required on the Yuba River. The objective flows are those listed in paragraph 8. With an 80 percent objective flow achievement assumed for the critical Feather River reach below Yuba River, the adjusted control flows were:

Reach	Limiting Discharges, cfs
Feather below Oroville	150,000
Yuba River at mouth	120,000
Feather River below Yuba River	240,000

The uncontrolled local flows below the operating reservoirs were increased by 25 percent to account for forecasting error when determining project releases. Project conditions include Oroville, Marysville, and New Bullards Bar Lakes operating with 750,000 acre-feet, 240,000 acre-feet, and 170,000 acre-feet, respectively, for flood control. Preproject conditions are represented by Oroville and New Bullards Bar Lakes operating, with the same flood control storages listed above, but without Marysville Lake. Both Feather and Yuba River centerings of the standard project storm were analyzed for preproject

conditions. The Yuba River centering produced the more critical preproject condition for the "Feather River below the mouth of the Yuba" and "Yuba River at mouth" index points and was used for further studies. For floods greater than the SPF, the Feather River centering was critical. Oroville Reservoir alone (without additional Yuba River storage) was not able to control to flow objectives on the Feather River below the mouth of the Yuba River. Figure F-2 displays the results for the Yuba River centering routings for preproject and project conditions.

c. Space requirements for alternative projects. - In order to obtain standard project flood protection with alternative projects, the following flood control reservations would be required.

Alternatives	Required flood control space (ac-ft)
Parks Bar single-purpose flood control (Yuba River Dam only) 1/	280,000
Browns Valley multipurpose	240,000
Browns Valley single-purpose flood control	301,000
EQ plan - Yuba River dam only (Parks Bar) 1/	260,000
Narrows	260,000

1/ Excludes Dry Creek.

d. Seasonal flood control space requirements. - To maximize the beneficial use of lake storage, flood control space would be reserved only as needed during periods of high runoff potential within the storm season. The seasonal storm potential has been related to latitude and to 10-year storm precipitation in "Reservoir Operation Criteria for Flood Control, Sacramento-San Joaquin Valley, California," dated October 1959. Considering generalized

criteria in that report and the large floods that have occurred in the Yuba River and adjoining basins, it was determined that the full flood control reservation should be available from 1 December through 21 March. Because of the downstream channel capacities, upstream flood control space in New Bullards Bar Lake, and the diminishing storm potential, it was determined that no flood control space would be required in Marysville Lake between 21 May and 31 August, as shown on the preliminary Flood Control Diagram Figure F-8. Ground wetness index parameters (a measure of the runoff potential of the area above Marysville Lake) are incorporated into the preliminary flood control diagram to further the beneficial use of lake storage. A study of the ground conditions preceding the largest floods of record in the Yuba River basin indicated that a ground wetness index of not less than 20.0 would precede standard project flood wet ground conditions, and that an index of not more than 8.0 would precede standard project flood dry ground conditions. Consequently, these indexes appear on Figure F-8 and alter the flood control reservation required according to antecedent ground wetness conditions. The end of month required flood control space at Marysville Lake, as determined from the Flood Control Diagram, for water years 1895 through 1971 is shown on Figure F-9.

e. Conservation operation. - Operation for conservation would be as follows:

(1) All inflow in excess of the releases necessary to fulfill downstream conservation rights to streamflow (including rights to diversion

of flow from the Sacramento-San Joaquin Delta) and releases required for fish would be stored, to the extent that conservation space in the lake is available, when there is excess water in the Delta.

(2) Releases of water stored for conservation purposes would be determined on a day-to-day basis by the U.S. Bureau of Reclamation unless release is required for flood control purposes.

f. Examples of operation. - Routings of the December 1955 and December 1964 floods through Marysville and New Bullards Bar Reservoirs are shown on Figures F-10 and F-11. These routings are made with the limiting project levee design flow in Yuba River of 120,000 cfs. Figure F-12 displays graphically the simulated conservation operation (from 1895 through 1971) and Figure F-13 displays reservoir stages for the same period, based on a monthly operation study made by the U.S. Bureau of Reclamation. Reservoir storage frequency and maximum annual pool elevation frequency data, based on the monthly hypothetical operation studies, are shown on Figures F-14 and F-15. Stage duration curves are shown on Figure F-16.

g. Responsibility for operation. - Marysville Lake would be operated by the U.S. Army Corps of Engineers, and would be under the jurisdiction of the District Engineer, Sacramento, California. The physical operation of the lake, under the supervision of the Construction-Operations Division, would be accomplished by full time damtenders. The functional operation of the lake to meet project objectives as a part of the Feather-Yuba River system

would be accomplished under the supervision of the Engineering Division, Reservoir Control Section.

12. Hydraulic design. -

Functional criteria considered in the hydraulic design of the outlet works and spillway at the Parks Bar site included objective flow requirements for irrigation and power generation, reservoir regulation requirements for control of the standard project flood, and safe passage of the probable maximum flood (PMF), downstream temperature requirements for fishery and irrigation use, emergency drawdown requirements, and diversion during construction. The following is a summary of pertinent hydraulic criterion for design, with a more detailed discussion of the hydraulic design, including emergency drawdown and model studies, contained in Appendix L, Basis of Design.

a. Yuba River main dam. - The spillway design was based on a total release capability of 100,000 cfs at the bottom of flood control pool (elevation 520.7 feet); a maximum surcharge of 5 feet above gross pool (elevation 560 feet) during passage of the PMF, and a maximum energy flux entering the stilling basin of less than 75,000 horsepower per foot of width. The spillway stilling basin was designed for a maximum discharge of 450,000 cfs, the maximum outflow during the PMF. Outlet works in the spillway section were designed to meet the maximum irrigation and water rights release of 4,400 cfs at pool elevation 428 feet and to meet the downstream water temperature requirements, in the event that releases through the power facilities are curtailed.

b. Dry Creek dam. - Emergency drawdown criteria was the controlling criterion for design of the outlet works at the Dry Creek dam when the pool elevation is below the connecting channel (elevation 400 feet). The outlet works would also serve to provide passage of flows during construction and to provide a small sustained flow (minimum 10 cfs) for stream maintenance.

c. Afterbay dam. - The afterbay dam and spillway for Stage I of the project were designed for operation of a 1,350 MW pumped-storage powerplant, with a gross pool elevation of 248 feet, a maximum discharge of 450,000 cfs, and a maximum surcharge of 5 feet. The afterbay dam and spillway would require minimum modification for Stage II of the project to provide storage for operation of a 2,250 MW pumped-storage powerplant. Design of the outlet works was based on a downstream release of 4,400 cfs at minimum pool elevation 193 feet, and the capability of draining the afterbay to elevation 170 feet. In the event the outlet works were temporarily out of service, irrigation releases could be made through the afterbay powerplant or by cracking one of the afterbay spillway gates. With the latter, gaging and control of releases would be less precise but would suffice for limited operation.

d. Emergency drawdown. - The emergency drawdown analysis was based on criteria presented in ER 1110-2-50, "Low Level Discharge Facilities for Drawdown of Impoundments," dated 8 May 1975. Starting storage for drawdown was taken at the top of spillway gates, elevation 562 feet. Inflow during drawdown was based on the average flow of the highest

consecutive 4-month historical period: 4,881 cfs for the Yuba River and 250 cfs for the Dry Creek arm. Drawdown was to be accomplished in a 4-month period with the spillway and outlet works capable of reducing the Yuba River arm storage by 90 percent (to elevation 337 feet) and the Dry Creek arm storage by 90 percent (to elevation 371 feet). Discharge was based on releases through the spillway and power facilities above spillway crest elevation 504 feet, releases through the power facilities and outlet works in the spillway section below elevation 504 feet, and releases through the Dry Creek outlet works below the elevation of the connecting channel (elevation 400 feet). Maximum release during the drawdown was held to 120,000 cfs, the design capacity for the downstream levees. The time required for drawdown to 90 percent of the main dam storage was 10 days, and the time required to achieve 90 percent drawdown of the Dry Creek storage was 117 days (110 days were required to drawdown Dry Creek storage from elevation 400 feet to elevation 371 feet), as shown on Figure F-20. Approximately 90 percent of the afterbay storage is above spillway crest elevation, 193 feet; therefore, drawdown of the afterbay dam can be achieved within the required time period.

13. <u>Reservoir regulation</u>. -

a. <u>General</u>. - Marysville Lake would have a gross capacity of 916,000 acre-feet. Of that capacity, a maximum of 240,000 acre-feet would be reserved during the flood season for coordinated operation with 170,000 acre-feet of storage space in the upstream New Bullards Bar Lake for

control of floods originating in the Yuba River basin, and with 750,000 acre-feet of storage space in Oroville Lake for control of floods on the Feather River. The Marysville Lake flood control space would be kept available, as required, in accordance with a plan of operation designed to meet the following coordinated system objectives for flood control within the Feather-Yuba basin.

(1) Except as may be required by the respective emergency spillway release diagrams, releases from Oroville Lake would not exceed 150,000 cfs, and the releases from Marysville Lake would not exceed 120,000 cfs.

(2) Flows in the Feather River below the mouth of the Yuba River would not exceed 300,000 cfs.

Detailed instructions for operation of Marysville Lake in conjunction with New Bullards Bar and Oroville Lakes will be presented in the Reservoir Regulation Manual.

b. Limitations on releases. - It is concluded that Marysville outflows should be limited to levee design capacity of 120,000 cfs when Feather River flows are high, since the successful operation of Marysville requires the coordination of reservoir releases by three different operating agencies. Limiting the Marysville releases to 120,000 cfs will minimize the possibility of operating error and provide a practical operating plan.

Since damage occurs within the project levees on the Yuba River, releases from Marysville Lake would be limited to inflow quantities already reached or exceeded during a flood. Unless emergency spillway releases are required, changes in releases from the project would be gradual in order to permit orderly evacuation of people, personal property, and livestock in advance of rising water. After extended periods of bankfull flows, releases would be reduced gradually to avoid or minimize riverbank caving. A limited rate of change in release of 10,000 cfs in any 2-hour period is considered to be reasonable and has been used in all operation studies. The emergency spillway release diagram would be developed for the project and would be included in the Reservoir Regulation Manual.

c. Releases for prior rights. - Operation of the Marysville Lake project is predicated on making releases from the project to satisfy all prior water rights and requirements, including 197,100 acre-feet per year for the Yuba County Water Agency (YCWA) (172,100 acre-feet for irrigation; 25,000 acre-feet for seepage) on an irrigation demand schedule in the months of March through October, on a firm yield basis, subject to normal reductions in low-flow years, all as set forth in the schedule presented in the IECO report "Post-Construction Reservoir Operation and Power Study" dated November 1969. Normal monthly releases from the Marysville Lake project to meet existing downstream diversion rights and requirements and allocations for seepage losses are listed on the next tabulation.

Fixed Releases for Prior Rights and Requirements Below Narrows
(Acre-Feet)

Month	Hallwood & Cordua	B.V.I.D.	Sub-Total	Yuba County Water Agency: Seepage Allowance	Yuba County Water Agency: Irrigation	Yuba County Water Agency: Sub-Total	Total
Jul	22,300	2,500	24,800	5,000	39,500	44,000	69,300
Aug	21,400	2,400	23,800	5,000	34,400	39,400	63,200
Sep	15,600	2,400	18,000	5,000	24,000	29,400	47,400
Oct	10,500	1,200	11,700	5,000	5,700	10,700	22,400
Nov	-	-	-	-	-	-	-
Dec	-	-	-	-	-	-	-
Jan	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-
Mar	1,100	-	1,100	-	1,700	1,700	2,800
Apr	8,700	1,200	9,900	-	8,500	8,500	18,400
May	19,500	2,400	21,900	2,000	25,500	27,500	49,400
Jun	21,600	2,400	24,000	3,000	32,400	35,400	59,400
TOTAL	120,700	14,500	135,200	25,000	172,100	197,100	332,300

Fixed releases, as shown for Hallwood, Cordua, and Browns Valley Irrigation District (BVID), were not subject to reductions during years of sub-normal streamflow, however, normal releases for YCWA were. The reduction criteria used are tabulated below. In applying the reduction criteria, full normal releases were made for YCWA until June, and when a reduction is indicated (based on the forecast for that year), it would go into effect from June through October.

Forecast Streamflow % of Normal	% Reduction in Normal New Releases
Above 85	0
51 - 85	15
50 or less	30

d. Releases for fishery. - Project releases would be made for fish to maintain minimum flows at the mouth of the Yuba River of 800 cfs in the months of October through January, 1,000 cfs in February through April, 800 cfs in May, and 600 cfs during the balance of the year, except during below-normal water years. A continuous flow (10 cfs minimum) would be released to Dry Creek to maintain the riparian vegetation and fishing resources along this tributary. Irrigation and fish requirements would be reduced in low runoff years beginning on 1 May and continuing through April of the following year when they would be reinstated in full unless another low runoff year is forecast. The criteria for reducing fishery requirements are as follows:

Forecast Streamflow % of Normal	% Reduction in Normal Release
Above 50	0
46 - 50	15
41 - 45	20
40 or less	30

e. Releases for power. - Project releases for prior rights and requirements and fishery resources would be made through the main powerplant at the Yuba River dam and the afterbay powerplant. Releases specifically for power would be made only from Marysville Lake, through the main powerplant, to the afterbay, and these releases would be stored in the afterbay and pumped back into Marysville Lake during off-peak periods. Releases of floodwaters would be made through the powerplants to the maximum extent feasible.

f. Hydrologic and communication facilities. - To insure dependable reservoir operation for flood control, the following facilities are required to obtain essential operating data. Provisions would be made for continuously measuring total outflow from Marysville Lake and the afterbay dam within an accuracy of 5 percent. Also, for the purpose of computing storage and inflow, provisions for continuously measuring lake stage at the dam to within 0.01 foot would be provided. Indicating dials would be located in the reservoir operating room and in the project office to show the stages at these gages. In addition, an external system of staff gages would be installed to provide a positive check on lake stage. Provisions would be made to obtain data from the radio-equipped precipitation stations installed in the basin to provide data for forecasting floodflows. Also, provisions would be made to obtain frequent reports from key stream gages at the mouth of the Yuba River and on the Feather River to provide data for coordinated flood control operation. An efficient radio communication system will be provided between the lakes and the Reservoir Control Section in the District Office.

g. Operational forecasting. - Since channel capacities of the Yuba River system greatly exceed maximum expected snowmelt floodflows, it is not considered necessary to forecast snowmelt runoff for flood control operation. Snowmelt forecasts will be used in determining conservation and power operation. However, to effectively operate the Yuba River lakes for control of rainfloods, it would be necessary to make frequent forecasts of inflow to Marysville and New Bullards Bar Lakes. An

appropriate method of forecasting the inflow hydrograph to Marysville Lake would be developed prior to adoption of final operating criteria. Although local inflow to the Yuba River below Marysville Lake is of minor importance, operation of the lake would be coordinated with this local inflow and with expected flows in the Feather River to avoid exceeding the channel capacity of the Feather River below its confluence with the Yuba River.

h. Relationship to other projects. - The operation of Marysville Lake would be closely coordinated with the operation of New Bullards Bar Lake to accomplish the flood control objectives along the Yuba River. A substantial portion of the flood control benefits attributed to storage on the Yuba River accrues from protecting areas along the Feather River during coincident floods. Therefore, to accomplish the flood control objectives along the Feather River, operation of Marysville Lake must be closely coordinated with that of other impoundments in the Feather-Yuba River system, particularly with that of Oroville Lake which is operated by the State of California.

14. Reservoir sedimentation. -

The trap efficiency of Marysville Lake is estimated to be 98 percent, and the average annual sediment rate is projected as 90 acre-feet. This would result in a total sediment deposition in 100 years of 9,000 acre-feet, or about 1 percent of the total reservoir capacity. Such a small volume would have no significant effect on project operation.

15. Freeboard requirements. -

Freeboard allowance for waves in Marysville Lake were recomputed for the Parks Bar site in accordance with Engineering Technical Letter No. 1110-2-221, dated 29 November 1976. Computations of maximum wave action freeboard requirements as outlined therein involves use of critical wind velocity and direction and an evaluation of maximum effective fetch approaching a dam or dike. No suitable wind records are available at the damsite; accordingly, information relative to wind velocities and directions were based on a study of winds at Beale Air Force Base (AFB), located near Marysville, during and following large storms. It was concluded that winds at Marysville damsite would not differ substantially from those at Beale AFB. The orientation and configuration of the reservoir is such that the maximum fetch toward the main dam on the Yuba River is east-southeast and toward the Dry Creek dam is north-northwest. The Yuba River dam produced the most critical condition for wind and fetch. A maximum overland wind (1 minute duration) of 36 miles per hour from the ESE direction was adopted. Computation of wave and wind tide characteristics based on the above criteria is summarized in the table below. A fetch diagram for the Yuba River and Dry Creek dams is shown on Figure F-17.

FREE BOARD CALCULATION - SUMMARY

Effective Fetch Length	3.10 Miles
Overwater to Overland Wind Velocity Ratio	1.262
Design Wind	
1. Wind Direction	ESE
2. Wind Velocity	36.5 MPH
3. Wind Duration	44 Min.
Design Wave	
1. Significant Wave Height (H_s):	2.7 Ft.
2. Significant Wave Period (T_s):	3.25 Sec.
Wave Runup	
1. Significant Runup (R_s):	3.19 Ft.
2. Maximum Runup (R_{max}):	4.78 Ft.
Wind Setup	
1. S	0.01 Ft.
Freeboard - Max.	
1. R_{max} + S =	4.79 Ft. (use 4.8 Ft.)

In view of the above, the top of dam elevation was established to provide 5 feet of freeboard above the spillway design flood pool.

16. Impairments and Yuba River streamflows. -

Studies were made of hypothetical streamflows in the Yuba River at the mouth both with and without the Marysville Lake project. These studies were based on irrigation withdrawals and seepage losses downstream of the Marysville Lake project and on data generated from an operation study for the New Bullards Bar project (International Engineering Co., Inc. (IECO), 1961). Data generated by these studies do not reflect historical streamflows,

but flows that would occur with full impairments (some of which have not been completely utilized in the past) as well as variations in annual basin runoff caused by changes in storage in New Bullards Bar Reservoir. Although there is presently more diversion from the river in the summer than in the past, the historical flows are substantially larger than impaired flows.

An analysis indicates the degree of impairment utilization and resultant streamflow in the Yuba River are dependent upon the climate, which is reflected in the annual Yuba River basin runoff. Yearly streamflows in the Yuba River are classified as "normal," "wet," or "dry." As a logical generalization, a greater degree of impairments is utilized during "dry" years than "normal" or "wet" years due to water availability.

A comparison was made between full natural flows, as shown in the IECO report, and historical flows for the period 1904-1967 in the Yuba River below Deer and Dry Creeks. A difference was noted in the relationship between impaired flows and historical flows before and after 1955, probably reflecting additional water depletions after 1955. The percent of impairments utilized in the period 1922-1955 is plotted as a function of annual basin runoff in Figure F-18. The data indicated that in extremely dry years depletions in the summer approach or exceed entitlements and that an increasingly smaller percentage of impairments is utilized as annual runoff increases.

For the years 1955-1967, a study was made by months of the difference between published flow data and IECO computed impaired flows to determine average current (post 1955) use of impairments. Curves were developed for

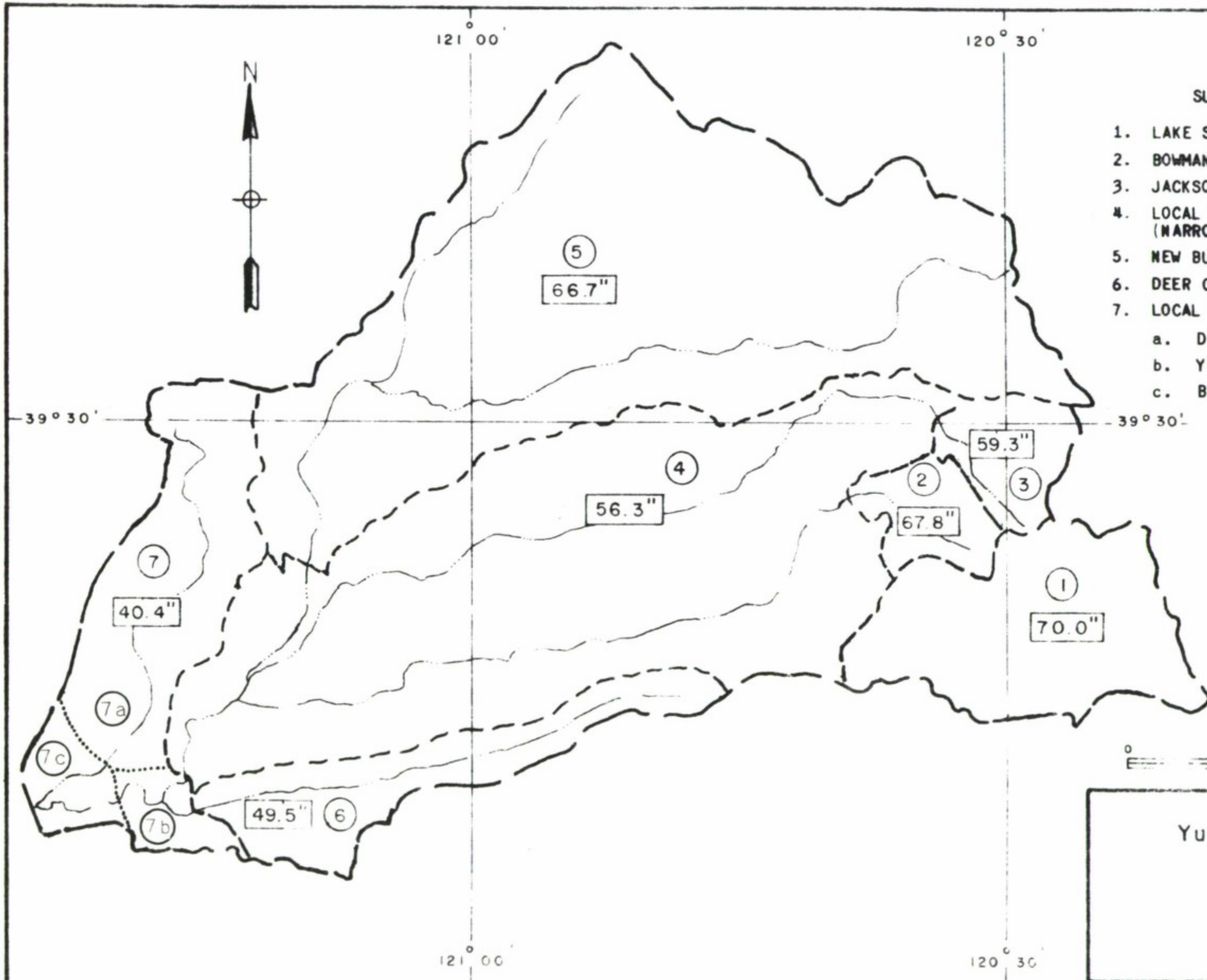
each month to determine the relationship between impairments not utilized and monthly basin runoff and to develop correction factors to be applied to fully impaired flows for the 1895-1971 period to develop partially impaired flows which reflect current and probable future use of impairments. It was determined that impairments are fully utilized in June through September and that an average correction can be used in all years in October, November, and December. The additions to full impairments to reflect current use are shown by years (1895 through 1971) for the months of January through May in the next tabulation. On the average, basin runoff was increased 173,000 acre-feet, or an average of about 10 percent, by considering partial impairments. The correction in any given year ranged between 71,000 acre-feet for a dry year and 271,000 acre-feet for a wet year as shown in Figure F-19. Operation studies for power were based on flows considering these partial impairments; however, studies for derivation of water supply yield from the Marysville Lake project were based on operation studies with fully impaired flows for a conservative analysis.

Additions to "Full Impairments" To Reflect Current Use

October - 16,000 acre-feet (260 cfs)
November- 14,000 acre-feet (235 cfs)
December- 10,000 acre-feet (163 cfs)
Jan, Feb, Mar, Apr, May - as listed below
Jun, Jul, Aug, Sep - impairments fully used, no modifications

Water Year	January 1,000 A-F	January cfs	February 1,000 A-F	February cfs	March 1,000 A-F	March cfs	April 1,000 A-F	April cfs	May 1,000 A-F	May cfs
1895	44	716	70	1,260	56	911	26	437	10	163
1896	53	862	58	1,044	18	293	42	706	9	146
1897	61	992	44	792	70	1,138	34	571	5	81
1898	4	65	7	126	6	98	3	50	2	33
1899	7	114	23	414	11	179	14	235	3	49
1900	61	992	44	792	70	1,138	34	571	5	81
1901	61	992	44	792	70	1,138	34	571	5	81
1902	61	992	44	792	70	1,138	34	571	5	81
1903	46	748	5	90	15	244	16	269	7	114
1904	17	276	92	1,657	99	1,610	44	739	23	374
1905	45	732	30	540	46	748	27	454	13	211
1906	69	1,122	30	540	77	1,252	36	605	24	390
1907	45	732	85	1,530	111	1,805	53	891	19	309
1908	31	504	14	252	23	374	20	336	11	179
1909	209	3,399	58	1,044	34	553	30	504	19	309
1910	41	667	26	468	53	862	32	538	10	163
1911	71	1,155	41	738	56	911	44	739	19	309
1912	12	195	6	108	12	195	9	151	13	211
1913	19	309	9	162	12	195	23	387	15	244
1914	105	1,708	23	414	31	504	33	555	22	358
1915	15	244	47	846	33	537	30	504	28	455
1916	50	813	55	990	61	992	38	639	17	276
1917	14	228	39	702	23	374	32	538	16	260
1918	4	65	13	234	28	455	21	353	8	130
1919	11	179	38	684	26	423	25	420	16	260
1920	5	81	5	90	18	293	20	336	10	163
1921	60	976	29	522	45	732	24	403	15	260
1922	17	276	33	594	26	423	26	437	28	455
1923	23	374	11	198	14	228	26	437	14	228
1924	6	98	11	198	5	81	6	101	2	33
1925	14	228	55	990	21	342	23	387	13	211
1926	8	130	41	738	18	293	28	471	7	114
1927	30	488	77	1,386	40	651	39	655	17	276
1928	25	407	15	270	77	1,252	29	487	11	179
1929	6	98	8	144	10	163	9	151	6	98
1930	23	374	20	360	29	472	17	286	7	114
1931	7	114	6	108	11	179	5	84	2	33
1932	19	309	19	342	24	390	17	286	15	244

Water Year	January 1,000 A-F	January cfs	February 1,000 A-F	February cfs	March 1,000 A-F	March cfs	April 1,000 A-F	April cfs	May 1,000 A-F	May cfs
1933	5	81	4	72	12	195	10	168	7	114
1934	16	260	13	234	17	276	7	118	2	33
1935	20	325	14	252	17	276	38	639	16	260
1936	44	716	53	954	28	455	28	471	14	228
1937	5	81	22	396	26	423	23	387	15	244
1938	18	293	44	792	73	1,187	36	605	26	423
1939	6	98	5	90	16	260	11	185	2	33
1940	46	748	57	1,025	67	1,040	30	504	13	211
1941	51	829	49	882	39	634	24	403	20	325
1942	67	1,090	54	972	22	358	32	538	18	293
1943	80	1,301	30	540	60	976	30	504	10	163
1944	6	98	10	180	19	309	11	185	9	146
1945	12	195	43	774	18	293	16	269	12	195
1946	35	569	13	234	22	358	22	370	12	195
1947	7	114	14	252	26	423	13	218	3	49
1948	22	358	5	90	10	163	28	471	14	228
1949	6	98	6	108	22	358	20	336	9	146
1950	25	407	29	522	25	407	25	420	14	228
1951	58	943	36	648	27	439	19	319	11	179
1952	48	781	50	900	36	585	40	672	30	488
1953	73	1,187	13	234	20	325	20	336	16	260
1954	17	276	23	414	33	537	26	437	8	130
1955	27	439	2	36	5	81	29	487	11	179
1956	110	1,789	55	990	25	407	10	168	10	163
1957	6	98	24	432	24	390	13	218	29	472
1958	26	423	77	1,386	62	1,008	79	1,328	11	179
1959	5	81	37	666	11	179	4	67	3	49
1960	7	114	41	738	26	423	9	151	8	130
1961	5	81	13	234	12	195	6	101	4	65
1962	7	114	53	954	29	472	16	269	7	114
1963	30	488	57	1,026	20	325	47	790	16	260
1964	26	423	8	144	7	114	8	134	4	65
1965	59	960	16	288	13	211	36	605	8	130
1966	13	211	12	216	8	130	5	84	2	33
1967	47	764	16	288	40	651	50	840	20	325
1968	10	163	34	612	21	342	9	151	4	65
1969	89	1,447	55	990	23	374	23	387	16	260
1970	44	716	25	450	10	163	4	67	6	98
1971	36	585	20	360	15	244	9	151	5	81



LEGEND

SUBBASIN	DRAINAGE AREA SQUARE MILES
1. LAKE SPAULDING	118
2. BOWMAN LAKE	27
3. JACKSON MEADOW DAM	37
4. LOCAL TO ENGLEBRIGHT (NARROWS) DAM	440
5. NEW BULLARDS BAR DAM	487
6. DEER CREEK	85
7. LOCAL TO MARYSVILLE	130
a. DRY CREEK DAM	(87)
b. YUBA RIVER DAM	(15)
c. BROWNS VALLEY SITE	(28)
TOTAL	1,324

SCALE IN MILES
0 5 10 15 20

NOTE:
Boxed figures denote Mean Annual Precipitation.

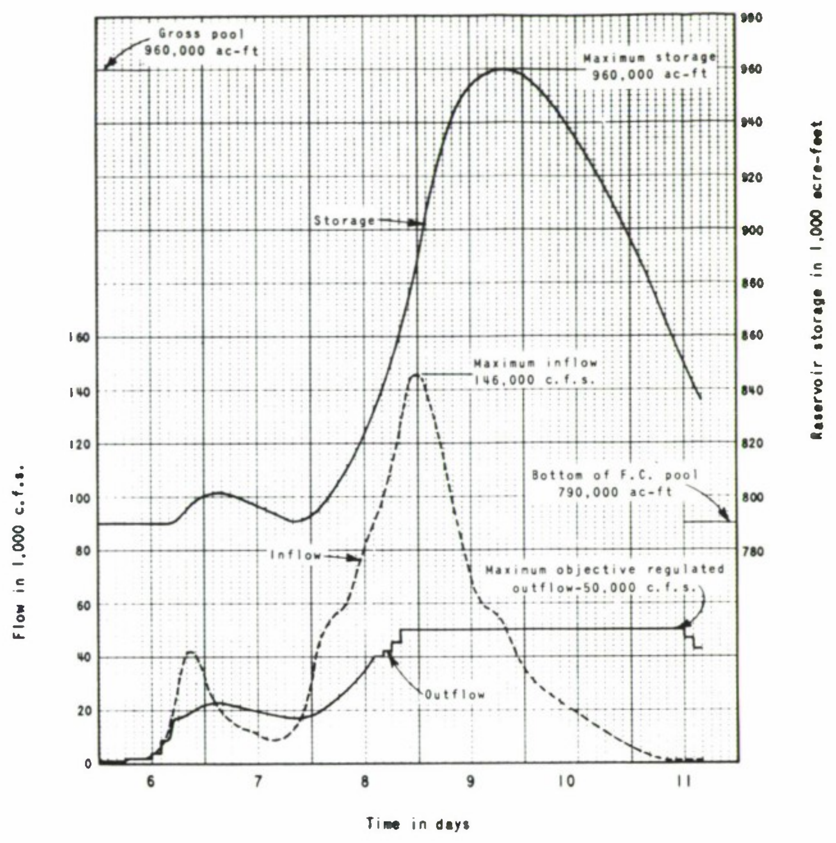
MARYSVILLE LAKE
Yuba River, California

BASIN MAP

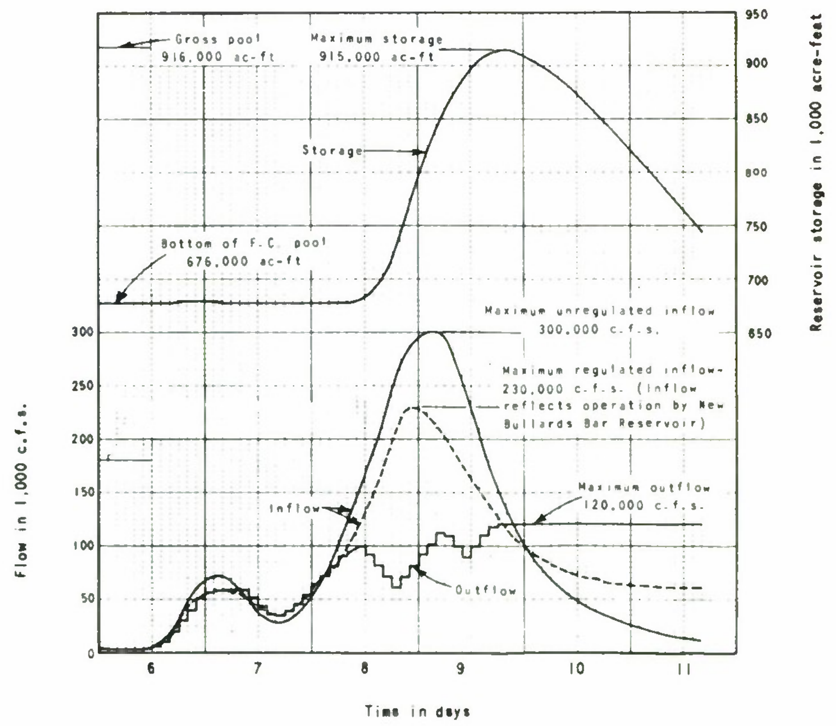
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared L.G.B.
Drawn L.K.K.
Date: JANUARY 1977

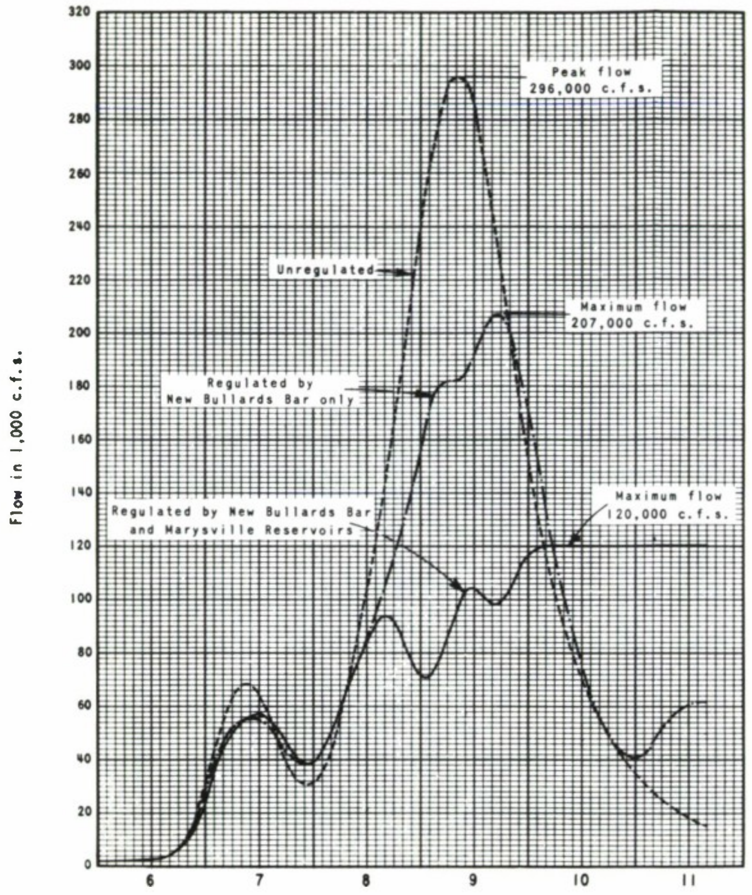
FIGURE F-1



New Bullards Bar Reservoir



Marysville Reservoir



Yuba River at Mouth - SPF Routing

NOTE:

Routings through Marysville Reservoir are based on the preliminary flood control diagram. Flows in the Feather River below Yuba River were limited to 80% of channel capacity (240,000 c.f.s.) to allow for operating contingencies.

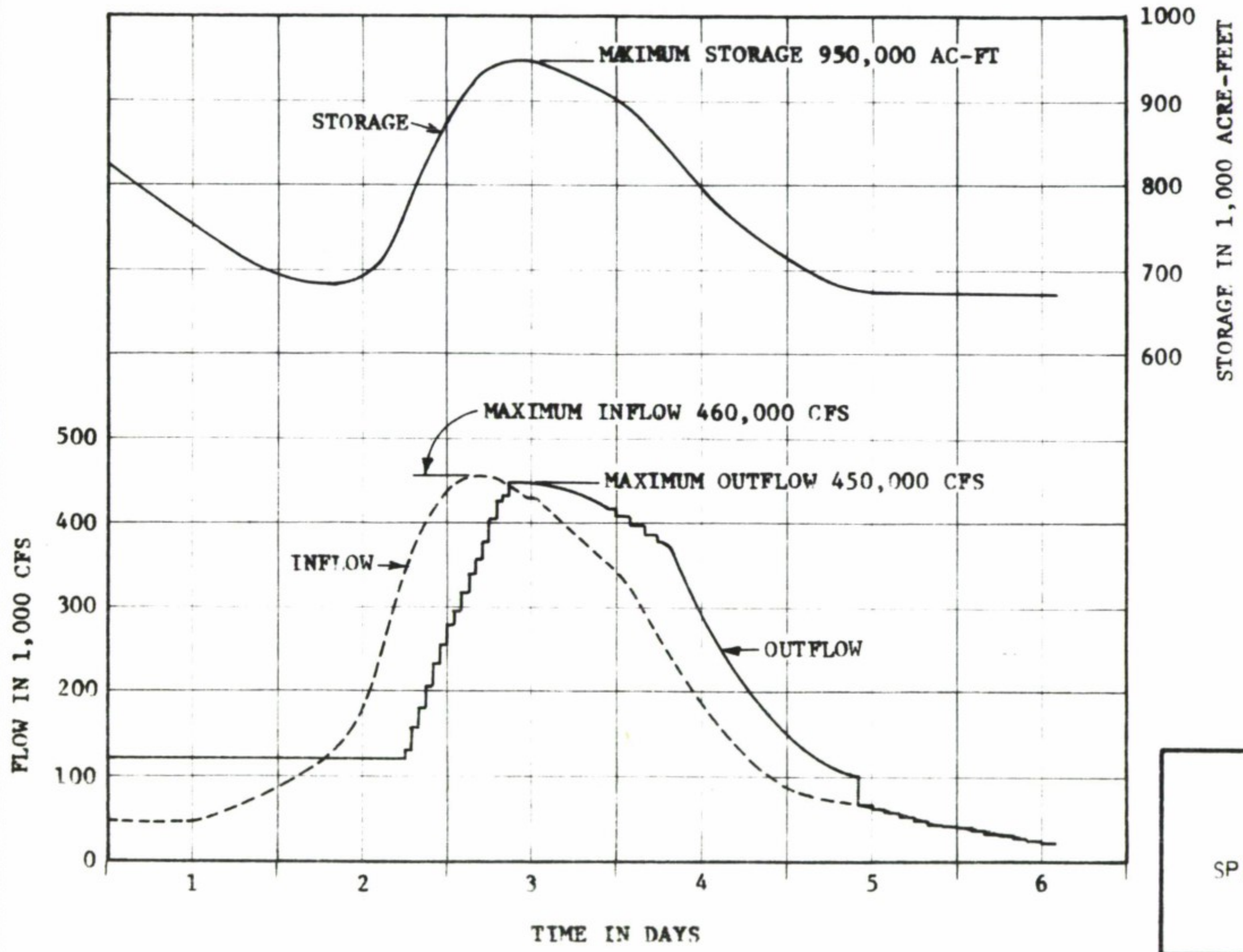
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

STANDARD PROJECT FLOOD ROUTINGS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: R.L.L., T.G.K.
Drawn: L.H.C., T.K.B.
Date: AUGUST 1975

FIGURE F-2



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

SPILLWAY DESIGN FLOOD ROUTING

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: W. J. & C. M. Date: JANUARY 1976
Drawn: T. K. B.

FIGURE F-3

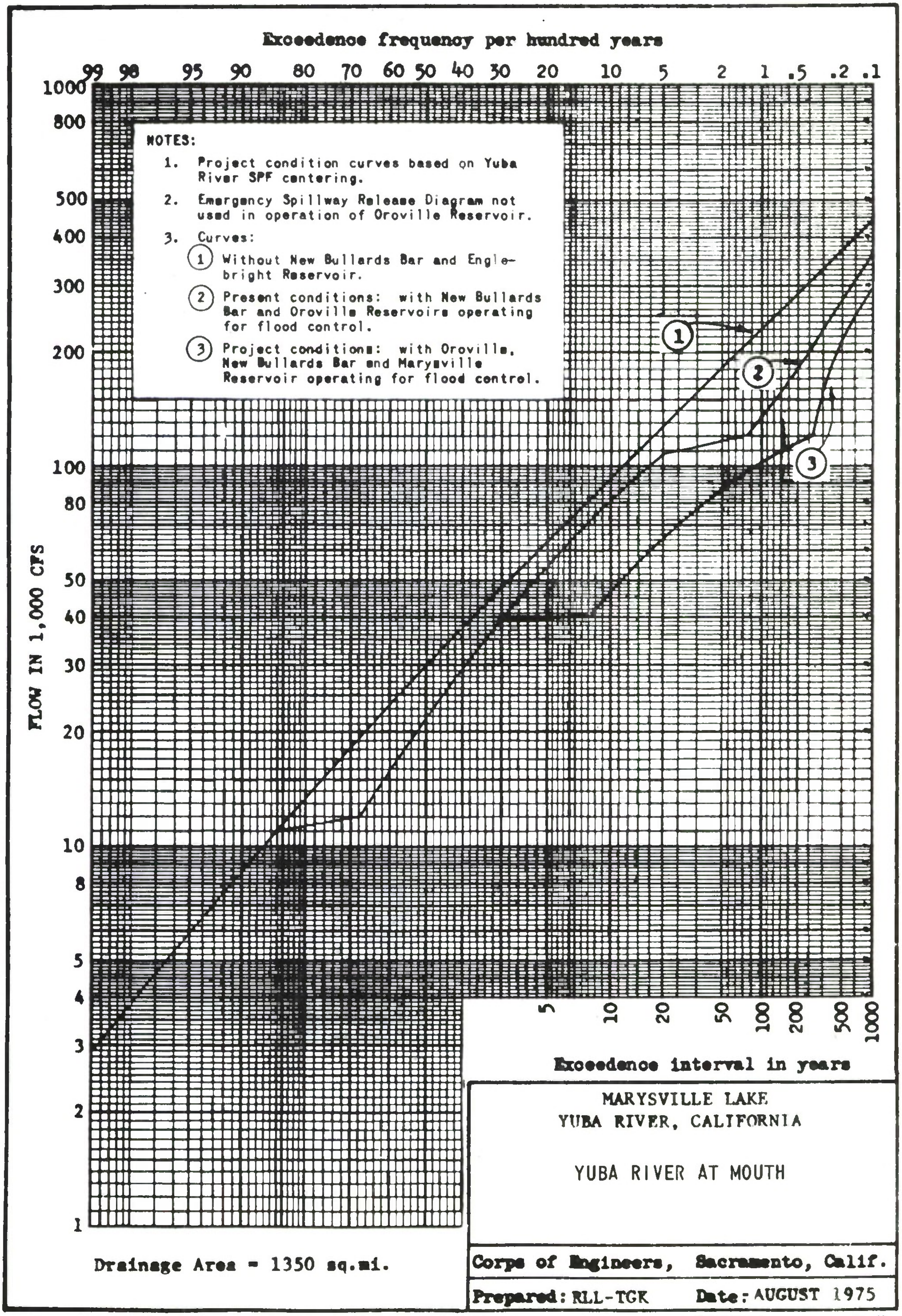

Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
1000
800
500
400
300
200
100
80
50
40
30
20
10
8
5
4
3
2
1
FLOW IN 1,000 CFS
NOTES:
1. Project condition curves based on Yuba River SPF centering.
2. Emergency Spillway Release Diagram not used in operation of Oroville Reservoir.
3. Curves:
1 Without New Bullards Bar and Englebright Reservoir.
2 Present conditions: with New Bullards Bar and Oroville Reservoirs operating for flood control.
3 Project conditions: with Oroville, New Bullards Bar and Marysville Reservoir operating for flood control.
1
2
3
5 10 20 50 100 200 500 1000
Exceedence interval in years
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
YUBA RIVER AT MOUTH
Drainage Area = 1350 sq.mi.
Corps of Engineers, Sacramento, Calif.
Prepared: RLL-TGK
Date: AUGUST 1975

FIGURE F-4

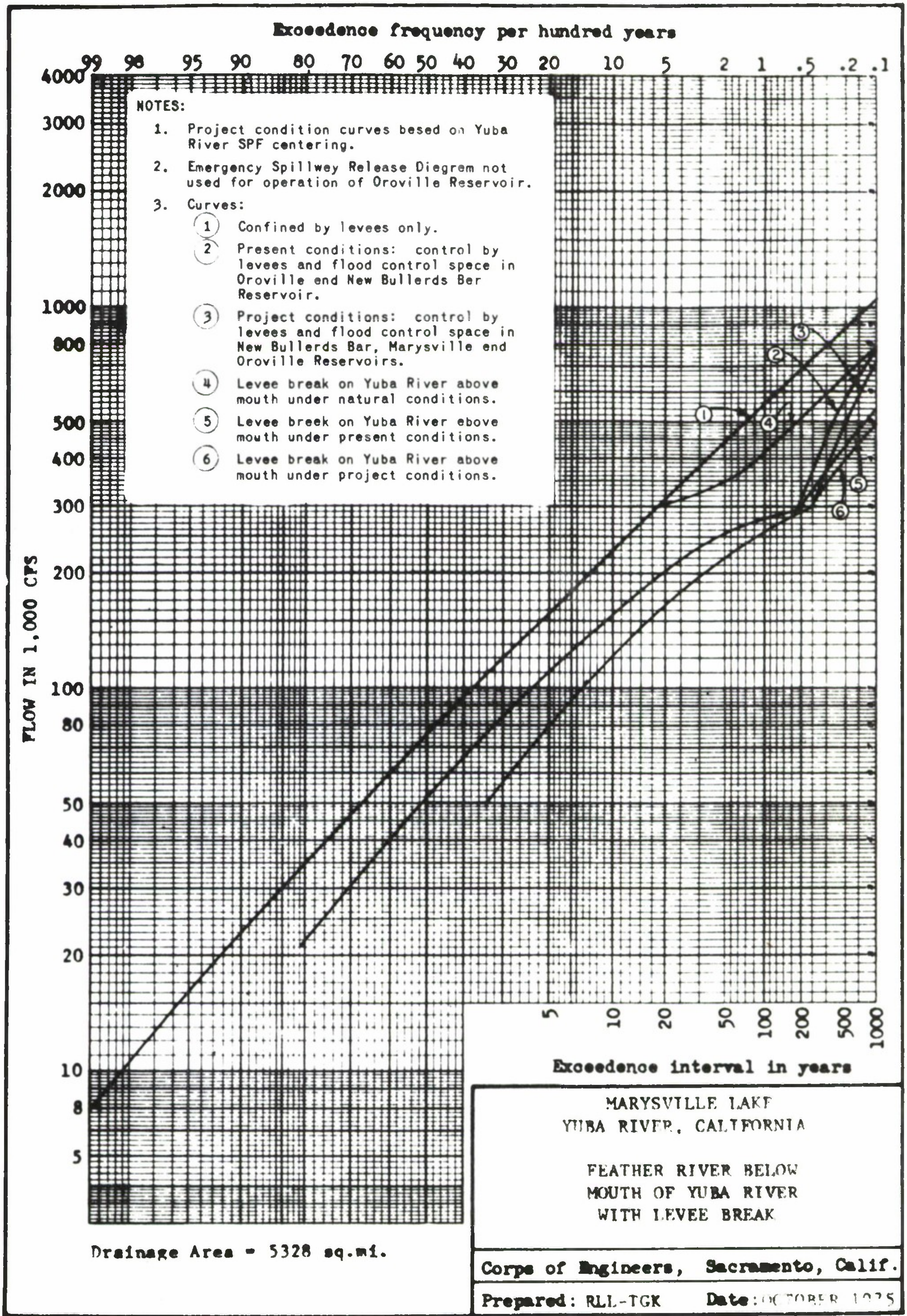

Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
FLOW IN 1,000 CFS
4000 3000 2000 1000 800 500 400 300 200 100 80 50 40 30 20 10 8 5
NOTES:
1. Project condition curves based on Yuba River SPF centering.
2. Emergency Spillway Release Diagram not used for operation of Oroville Reservoir.
3. Curves:
1 Confined by levees only.
2 Present conditions: control by levees and flood control space in Oroville and New Bullards Bar Reservoir.
3 Project conditions: control by levees and flood control space in New Bullards Bar, Marysville and Oroville Reservoirs.
4 Levee break on Yuba River above mouth under natural conditions.
5 Levee break on Yuba River above mouth under present conditions.
6 Levee break on Yuba River above mouth under project conditions.
5 10 20 50 100 200 500 1000
Exceedence interval in years
Drainage Area = 5328 sq.mi.
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
FEATHER RIVER BELOW
MOUTH OF YUBA RIVER
WITH LEVEE BREAK
Corps of Engineers, Sacramento, Calif.
Prepared: RLL-TGK Date: OCTOBER 1975

FIGURE F-5

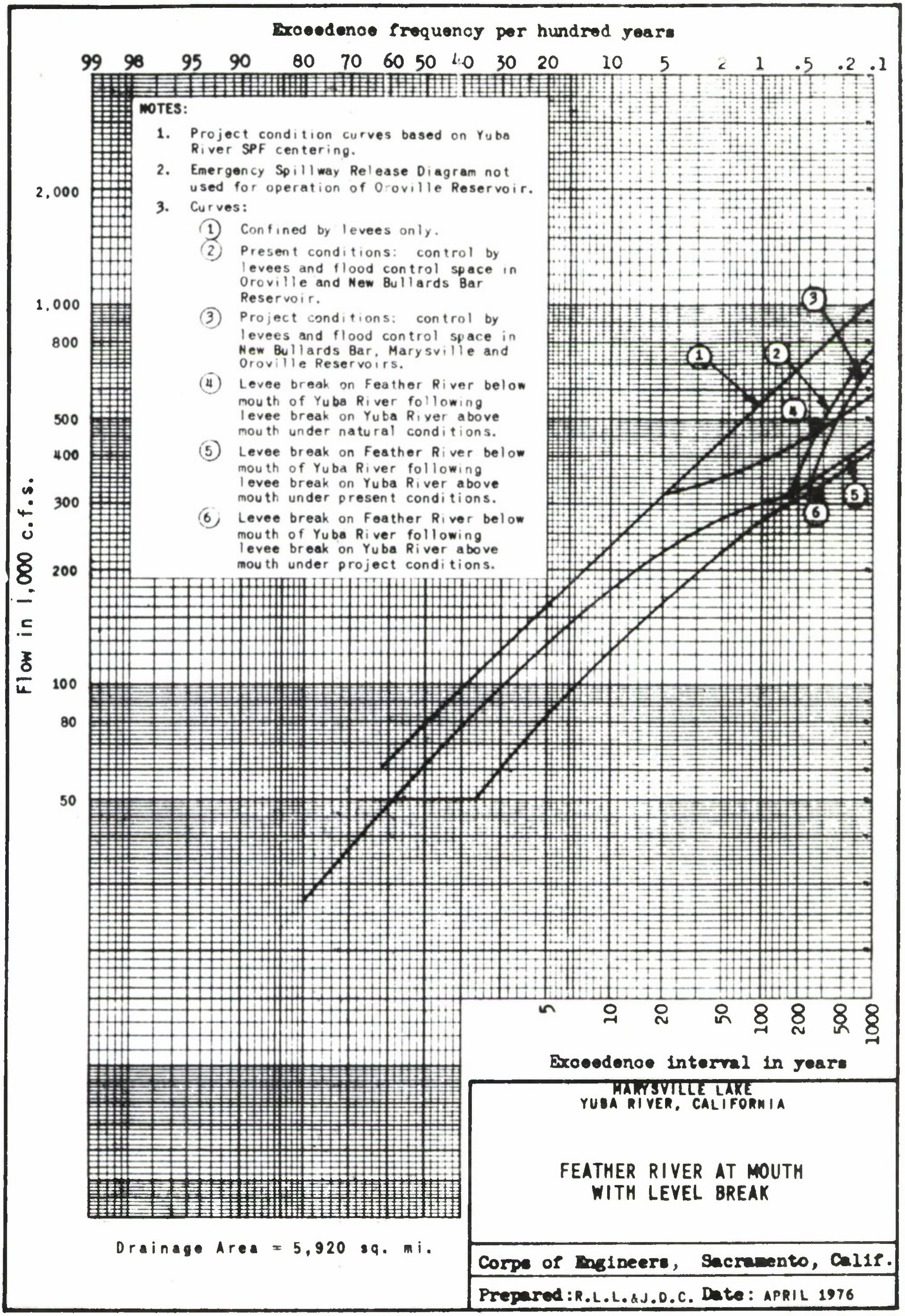
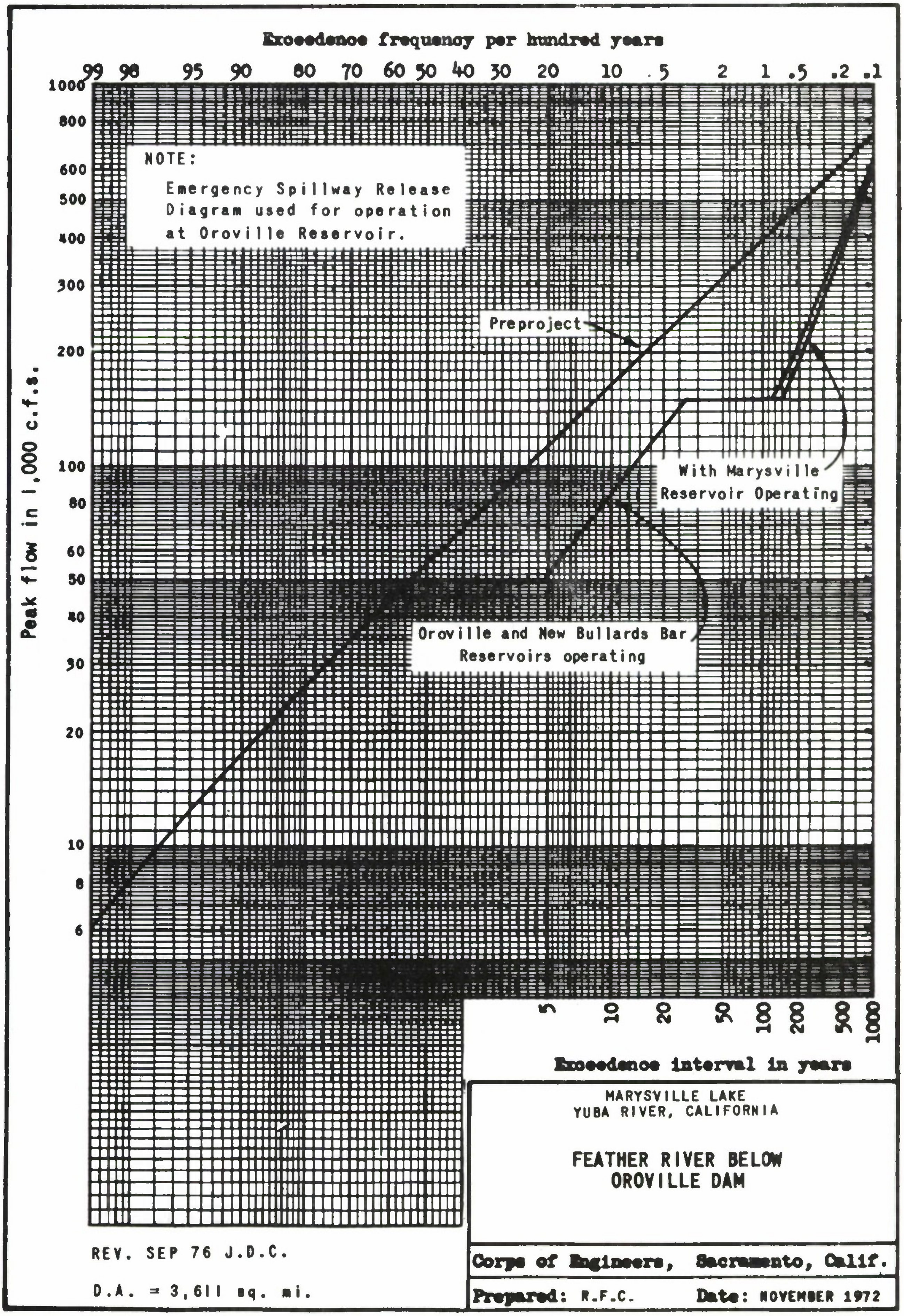

Exceedence frequency per hundred years
99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 .5 .2 .1
NOTES:
1. Project condition curves based on Yuba River SPF centering.
2. Emergency Spillway Release Diagram not used for operation of Oroville Reservoir.
3. Curves:
1 Confined by levees only.
2 Present conditions: control by levees and flood control space in Oroville and New Bullards Bar Reservoir.
3 Project conditions: control by levees and flood control space in New Bullards Bar, Marysville and Oroville Reservoirs.
4 Levee break on Feather River below mouth of Yuba River following levee break on Yuba River above mouth under natural conditions.
5 Levee break on Feather River below mouth of Yuba River following levee break on Yuba River above mouth under present conditions.
6 Levee break on Feather River below mouth of Yuba River following levee break on Yuba River above mouth under project conditions.
Flow in 1,000 c.f.s.
2,000
1,000
800
500
400
300
200
100
80
50
1 2 3 4 5 6
5 10 20 50 100 200 500 1000
Exceedence interval in years
Drainage Area = 5,920 sq. mi.
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
FEATHER RIVER AT MOUTH
WITH LEVEL BREAK
Corps of Engineers, Sacramento, Calif.
Prepared: R.L.L.&J.D.C. Date: APRIL 1976

FIGURE F-6



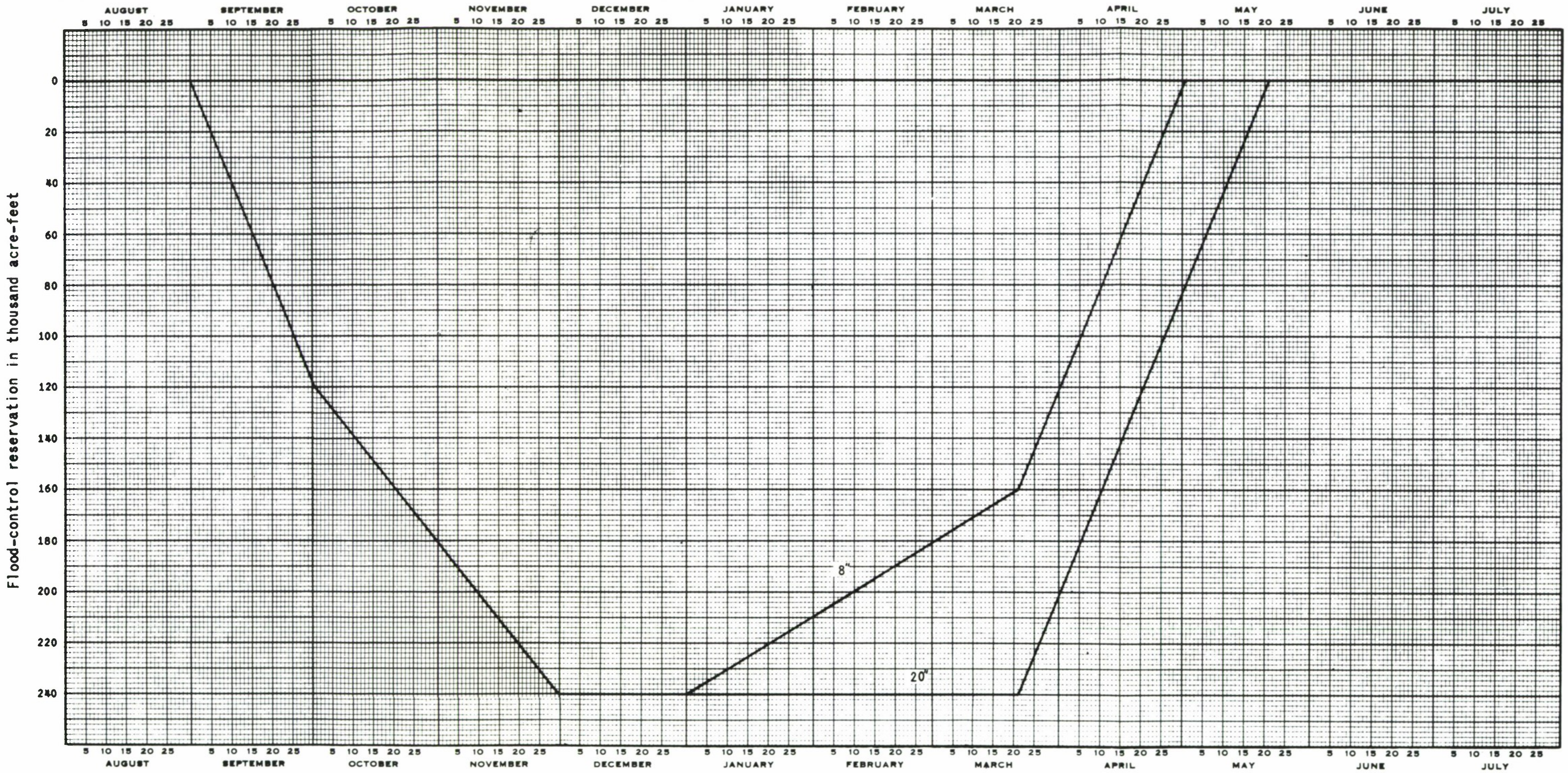
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

FEATHER RIVER BELOW
OROVILLE DAM

Corps of Engineers, Sacramento, Calif.

Prepared: R.F.C. Date: NOVEMBER 1972

FIGURE F-7



NOTES:

1. Parameters are the accumulated basin mean precipitation for the season, multiplied daily by 0.97.
2. Except when releases are required by the emergency spillway release diagram, water stored in the flood control reservation defined hereon shall be released as rapidly as possible, subject to the following conditions:
   a. That flows in the Yuba River at the mouth do not exceed the lesser of 120,000 c.f.s. or maximum rate of inflow for the flood.
   b. That releases do not cause flows in the Feather River below the mouth of Yuba River to exceed 300,000 c.f.s.
   c. That releases are not increased or decreased more than 10,000 c.f.s. in any 2-hour period.

MARYSVILLE LAKE YUBA RIVER, CALIFORNIA PRELIMINARY FLOOD CONTROL DIAGRAM MARYSVILLE LAKE	
CORPS OF ENGINEERS,	SACRAMENTO, CALIFORNIA
Prepared: R.L.L. Drawn: T.G.K.	Date: OCTOBER 1975

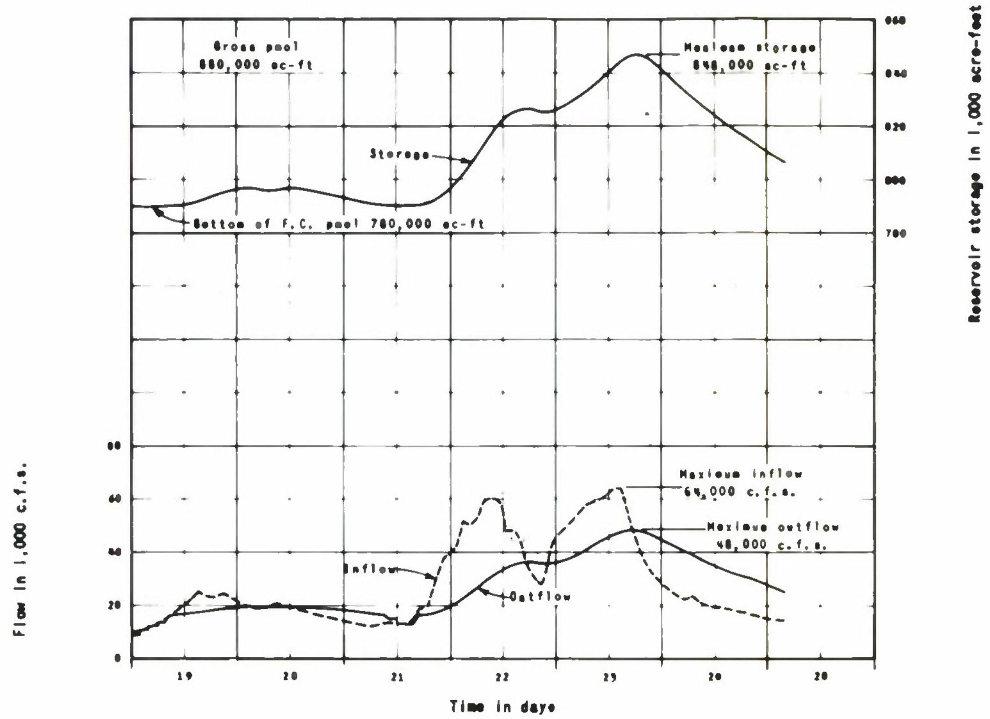
FIGURE F-8

PRELIMINARY MONTHLY REQUIRED FLOOD CONTROL SPACE
MARYSVILLE LAKE

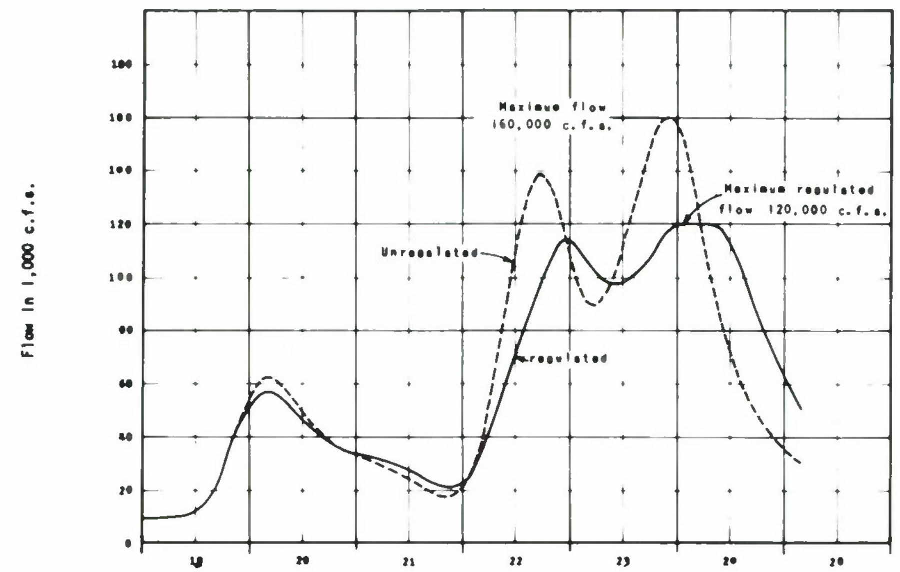
OCTOBER 1975

Water Year	Flood Control Space in thousand acre-feet at end of month											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1895	180.0	240.0	240.0	240.0	210.5	135.3	2.6	0.0	0.0	0.0	0.0	116.0
1896				235.7	182.9	129.9	45.9					
1897				209.4	200.9	141.3	2.6					
1898				209.4	188.2	120.7	2.6					
1899				209.4	180.7	160.5	2.6					
1900				209.9	180.7	120.7	2.6					
1901				213.6	218.8	122.1	2.6					
1902				209.4	231.8	136.0	2.6					
1903				227.2	181.2	165.3	2.6					
1904				209.4	240.0	200.7	53.6					
1905				210.8	180.7	146.1	2.6					
1906				232.9	196.0	200.7	28.8					
1907				224.9	210.3	200.7	31.7					
1908				214.1	180.7	120.7	2.6					
1909				240.0	240.0	150.6	2.6					
1910				219.5	187.1	125.1	2.6					
1911				240.0	223.3	147.4	2.6					
1912				209.4	180.7	120.7	2.6					
1913				211.6	180.7	120.7	2.6					
1914				240.0	235.1	127.2	2.6					
1915				219.8	237.6	144.7	2.6					
1916				240.0	212.5	133.7	2.6					
1917				209.4	214.3	123.4	2.6					
1918				209.4	187.7	141.1	3.4					
1919				209.4	218.7	133.3	2.6					
1920				209.4	180.7	128.0	2.6					
1921				232.6	195.7	127.9	2.6					
1922				212.3	237.4	174.1	2.6					
1923				219.7	180.7	120.7	2.6					
1924				209.4	180.7	120.7	2.6					
1925				209.4	205.9	129.7	2.6					
1926				209.4	197.9	120.7	2.6					
1927				212.1	218.5	133.2	2.6					
1928				209.4	180.7	169.4	5.7					
1929				209.4	180.7	120.7	2.6					
1930				211.7	182.3	120.7	2.6					
1931				209.4	180.7	120.7	2.6					
1932				220.9	182.7	120.7	2.6					
1933				212.5	180.7	120.7	2.6					
1934				209.4	181.2	120.7	2.6					
1935				211.7	181.0	124.8	22.8					
1936				217.9	236.0	153.2	2.6					
1937				220.2	194.3	147.4	9.8					
1938				210.4	221.3	180.7	13.4					
1939				209.4	180.7	120.7	2.6					
1940				223.1	240.0	200.7	19.9					
1941				233.9	228.8	136.8	6.0					
1942				229.5	209.4	120.7	16.6					
1943				240.0	203.1	155.4	7.5					
1944				209.4	198.2	120.7	2.6					
1945				209.4	190.3	128.4	2.6					
1946				213.6	180.7	131.3	2.6					
1947				209.4	180.7	137.2	2.6					
1948				209.4	180.7	124.0	42.0					
1949				209.4	180.7	134.5	2.6					
1950				230.1	197.9	146.4	2.6					
1951				229.6	198.2	120.7	2.6					
1952				240.0	224.3	160.2	2.6					
1953				227.2	180.7	124.7	18.6					
1954				215.6	195.2	144.2	11.0					
1955				209.4	180.7	120.7	4.8					
1956				240.0	229.9	120.7	2.6					
1957				209.4	207.8	137.9	2.6					
1958				220.8	237.3	199.3	31.3					
1959				214.9	205.4	121.9	2.6					
1960				216.0	203.7	148.0	2.6					
1961				209.4	180.7	127.6	2.6					
1962				209.4	225.3	142.9	2.6					
1963				220.6	189.0	145.8	35.5					
1964				213.8	180.7	120.7	2.6					
1965				239.4	190.3	120.7	4.6					
1966				212.9	180.7	120.7	2.6					
1967				240.0	189.5	153.7	28.8					
1968				214.7	195.8	121.1	2.6					
1969				240.0	240.0	130.6	2.6					
1970				240.0	215.0	123.5	2.6					
1971	180.0	240.0	240.0	215.1	180.7	128.2	2.6	0.0	0.0	0.0	0.0	116.0

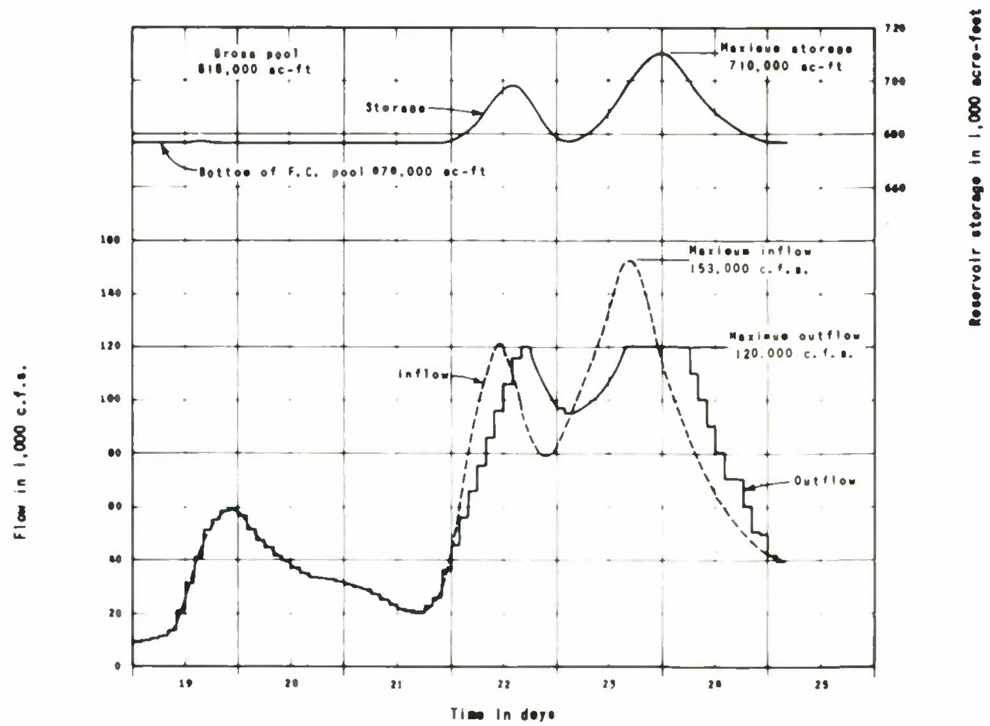
FIGURE F-9



Time in days
DECEMBER 1955
NEW BULLARDS BAR RESERVOIR



Time in days
DECEMBER 1955
YUBA RIVER AT MOUTH



Time in days
DECEMBER 1955
MARYSVILLE RESERVOIR

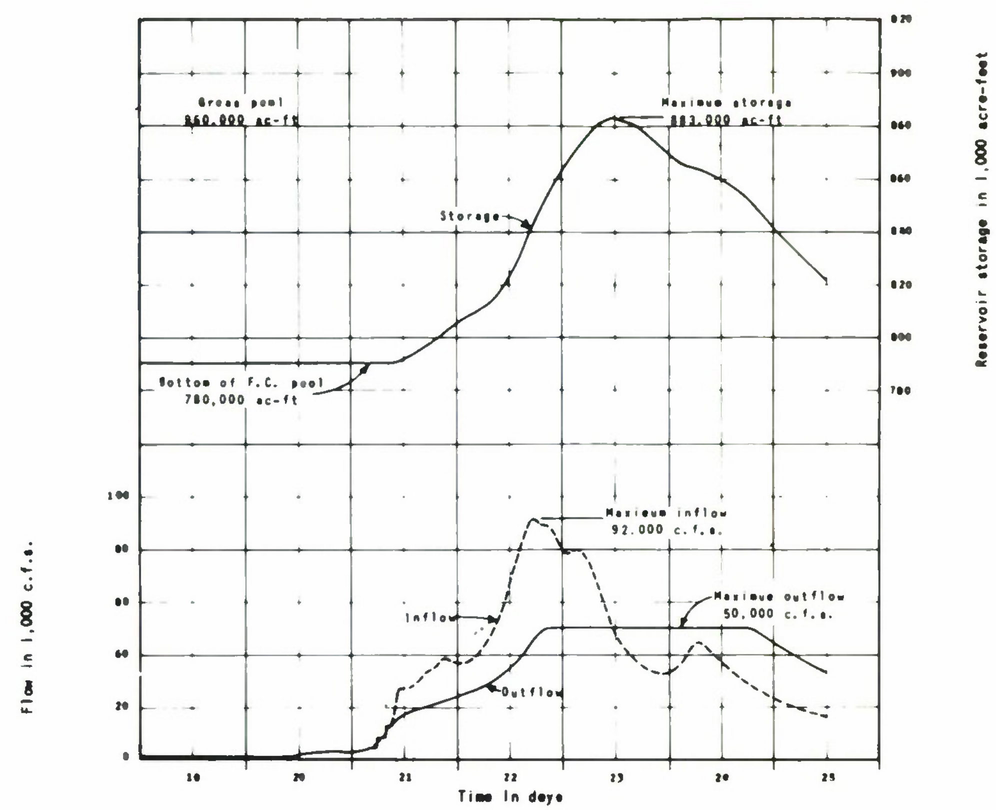
NOTE:
Routings through Marysville Reservoir are made in conformity with the preliminary flood control diagram.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

FLOOD ROUTINGS
DECEMBER 1955 FLOOD

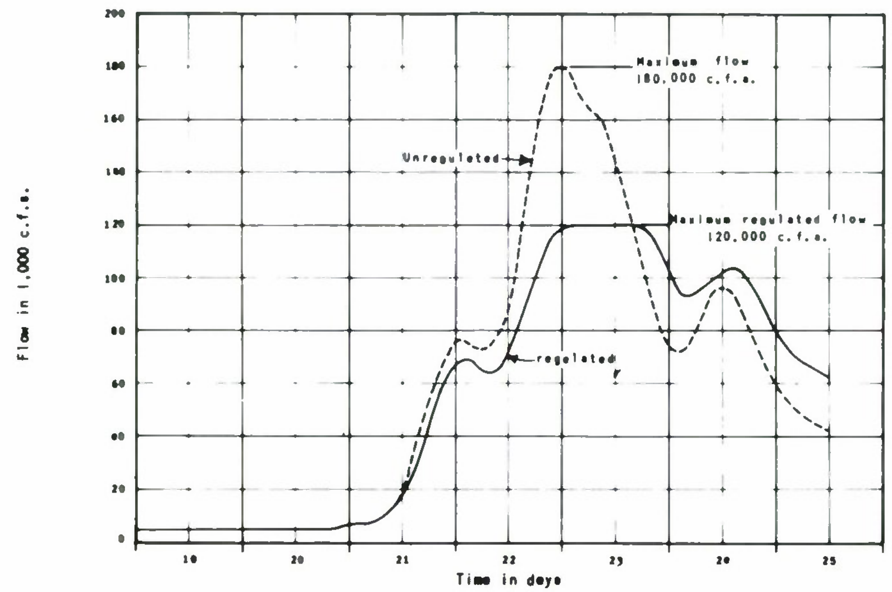
CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
Prepared: R.L.L.
Drawn: T.K.B.
Date: OCTOBER 1975

FIGURE F-10



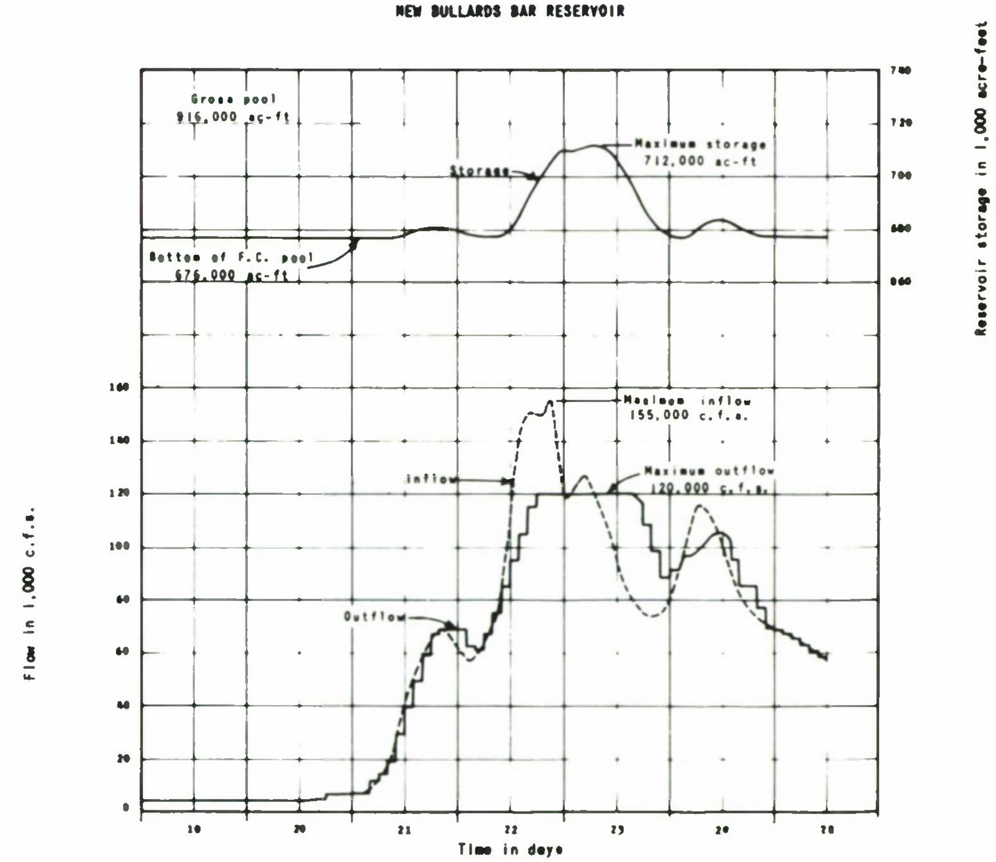
DECEMBER 1964

NEW BULLARDS BAR RESERVOIR



DECEMBER 1964

YUBA RIVER AT MOUTH



DECEMBER 1964

MARYSVILLE RESERVOIR

NOTE:

Routings through Marysville Reservoir are made in conformity with the preliminary flood control diagram.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

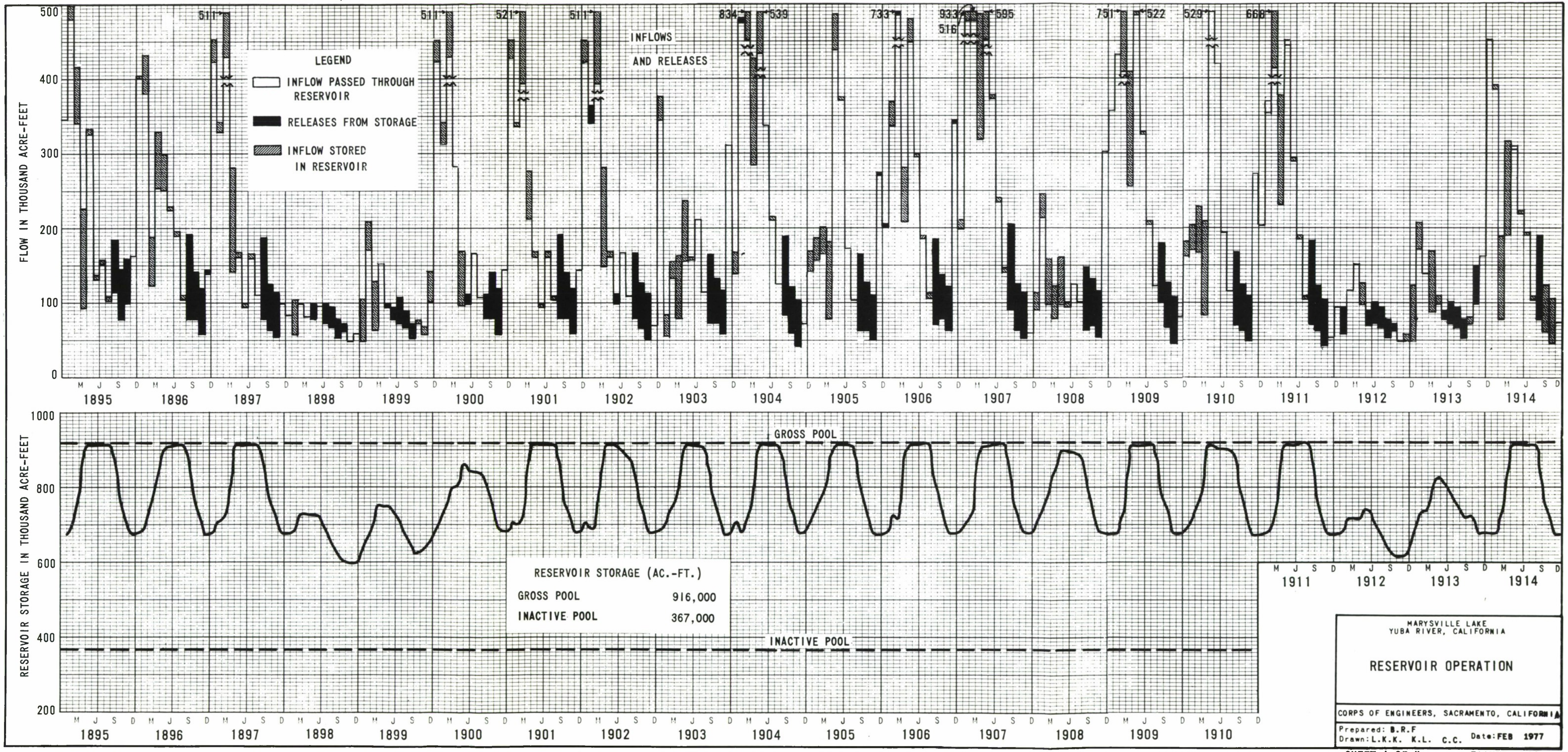
FLOOD ROUTINGS
DECEMBER 1964 FLOOD

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: R.L.L.

Drawn: T.K.B. DATE: OCTOBER 1975

FIGURE F-11



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

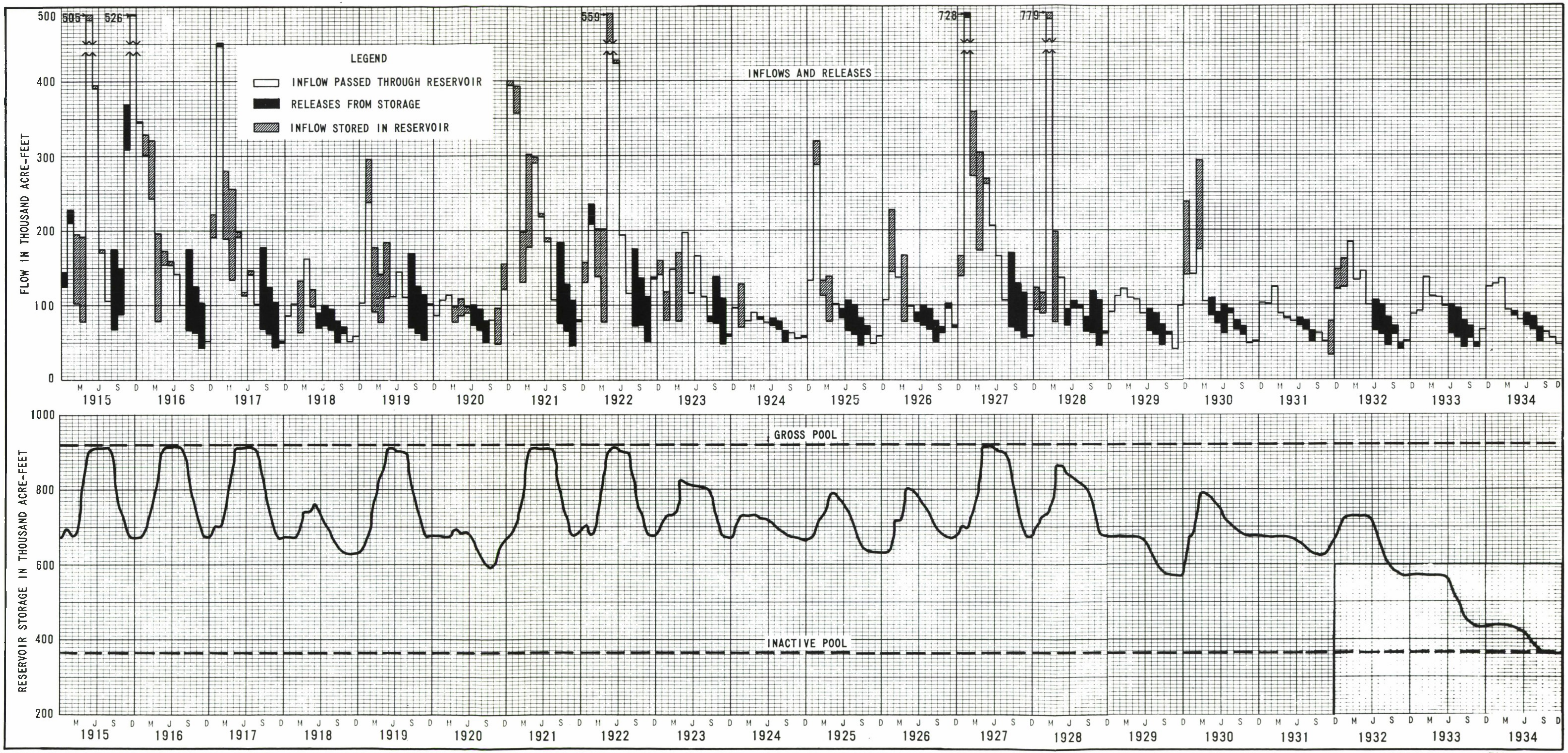
RESERVOIR OPERATION

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

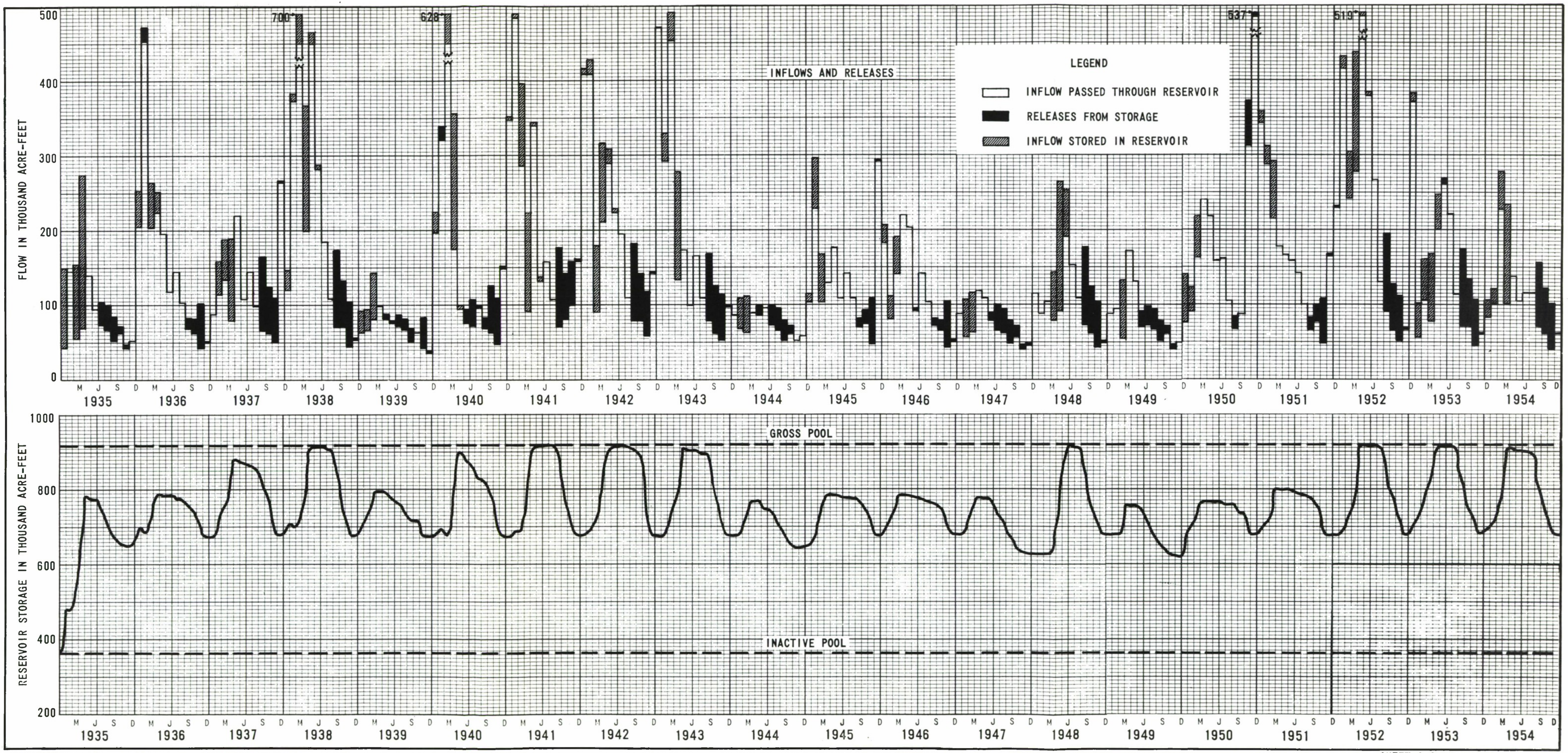
Prepared: B.R.F
Drawn: L.K.K. K.L. C.C. Date: FEB 1977

SHEET 1 OF 4

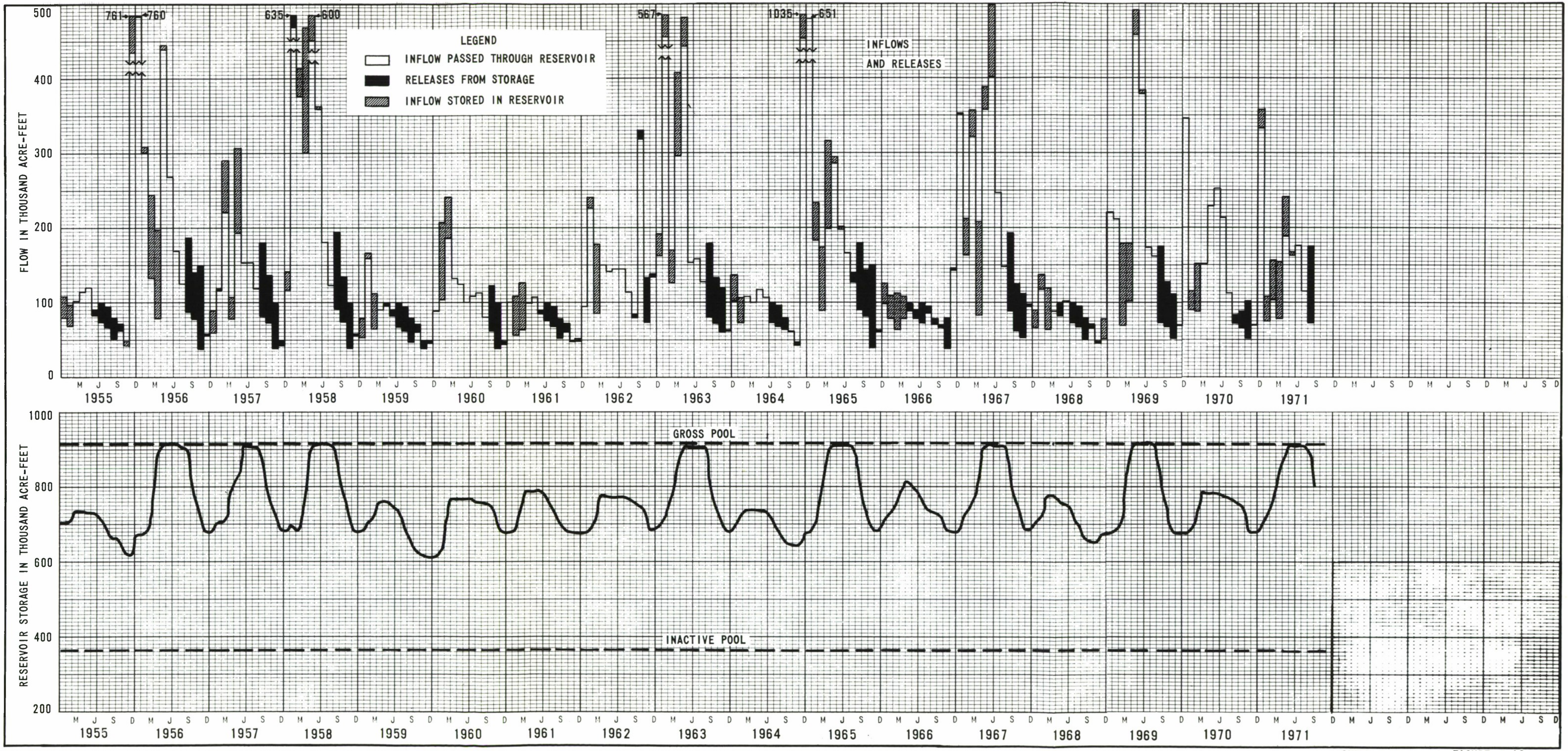
FIGURE F-12



SHEET 2 OF 4 FIGURE F-12

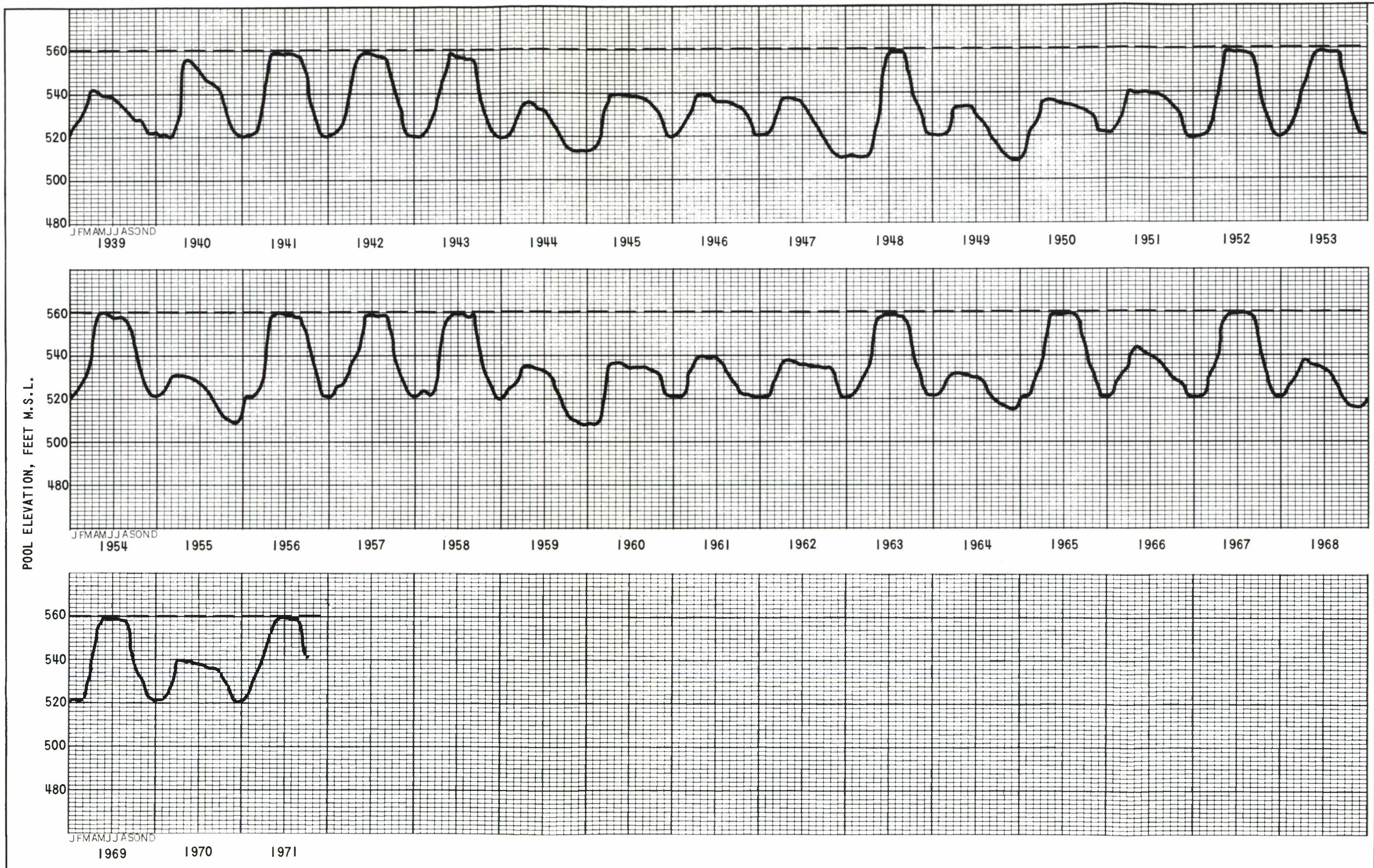


SHEET 3 OF 4 FIGURE F-12



SHEET 4 OF 4

FIGURE F-12

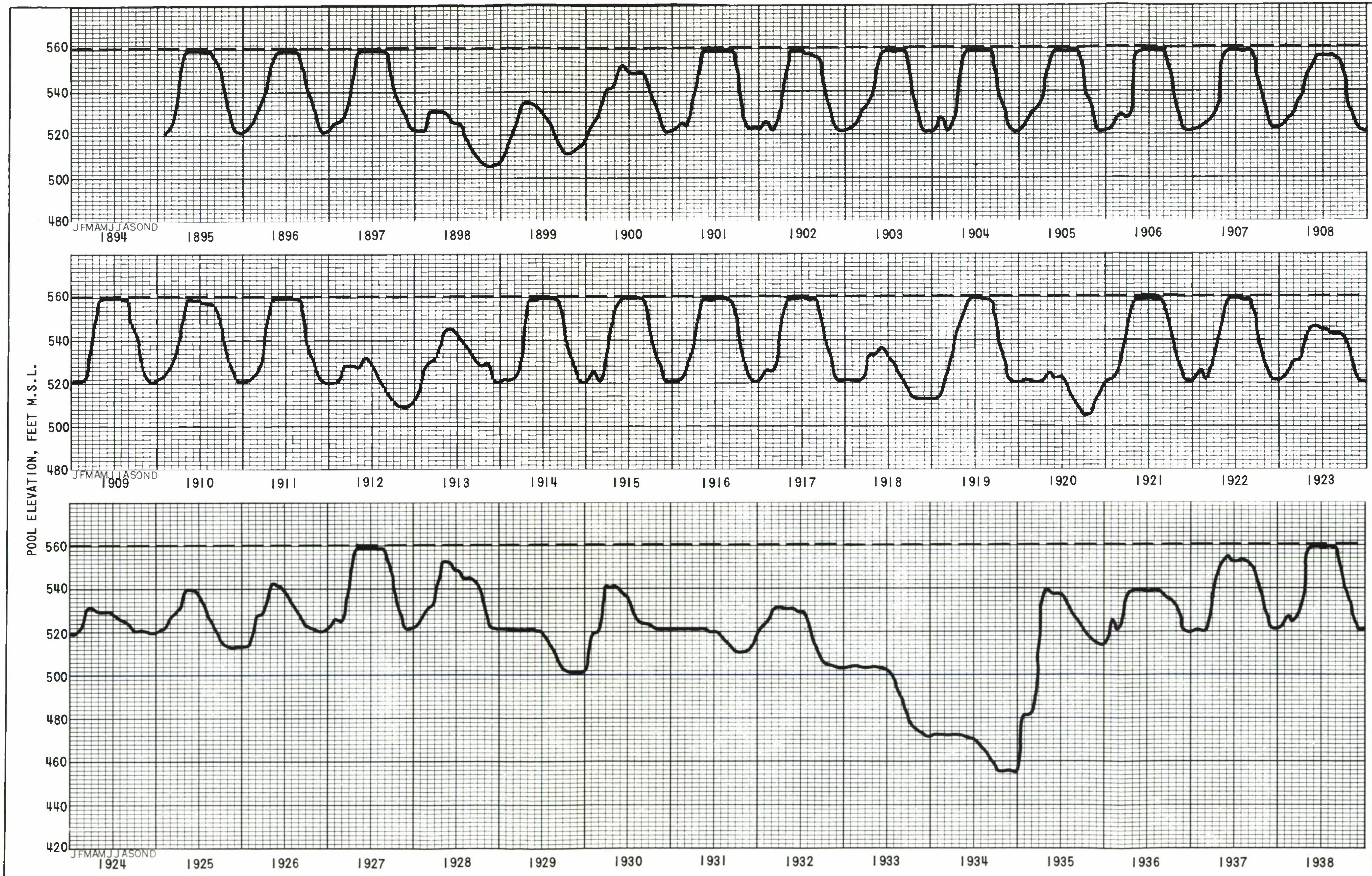


NOTE:

From September 1976 USBR operation study, 560' gross pool, 1895-1971, 367,000 AF minimum pool, partial impairments.

MARYSVILLE LAKE YUBA RIVER, CALIFORNIA END-OF-MONTH POOL ELEVATION	
CORPS OF ENGINEERS	SACRAMENTO, CA
PREPARED: B.R.F. DRAWN: L.K.K.	DATE JANUARY 1977

SHEET 2 OF 2 FIGURE F-13



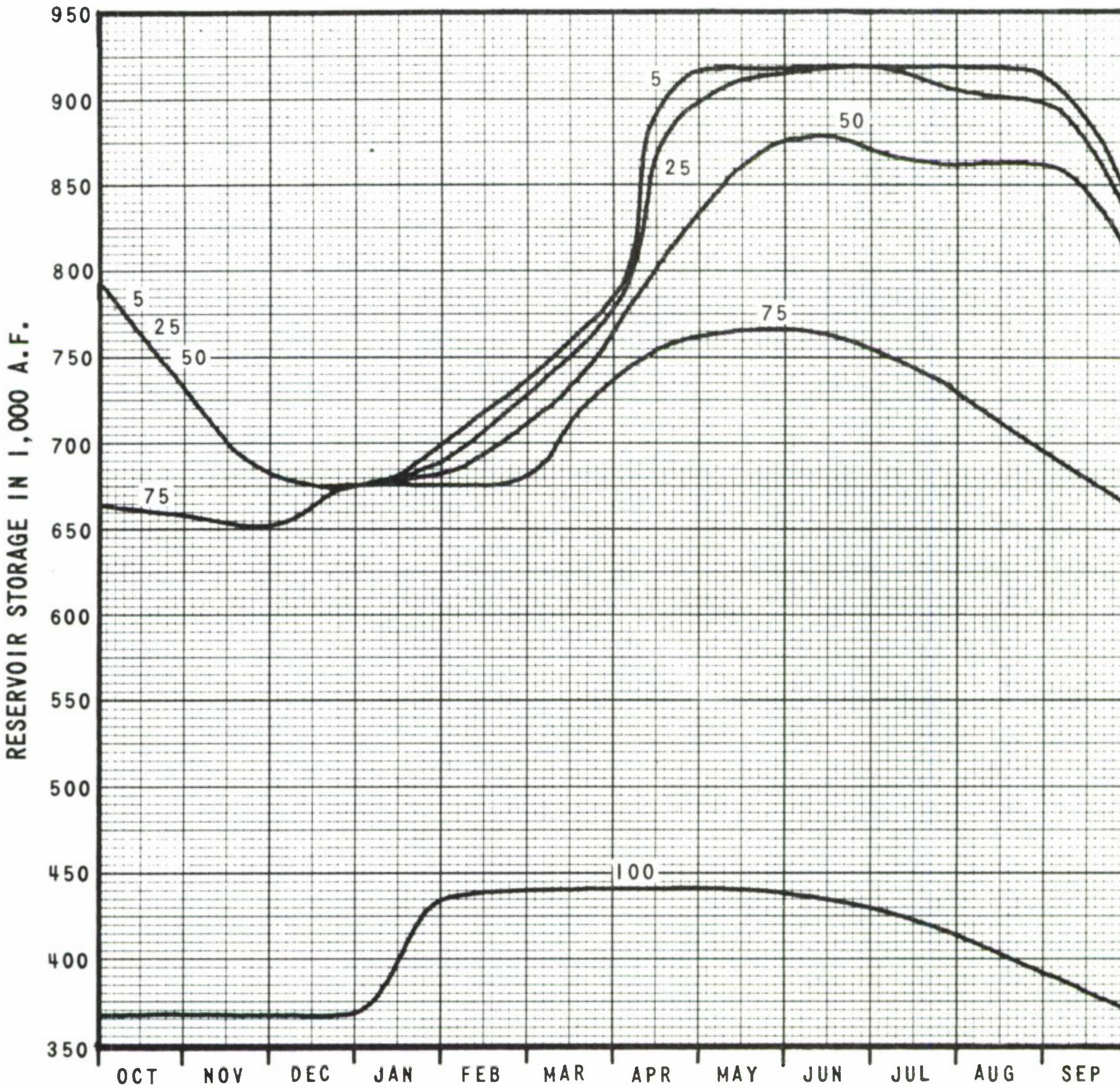
NOTE:

From September 1976 USBR operation study, 560' gross pool, 1895-1971, 367,000 AF minimum pool, partial impairments.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

END-OF-MONTH POOL ELEVATION

CORPS OF ENGINEERS SACRAMENTO, CA
PREPARED: B.R.F.
DRAWN: L.K.K.
DATE JANUARY 1977
SHEET 1 OF 2
FIGURE F-13



NOTE:

Indicated value is percentage of years that storage is exceeded on a given date based on total end of month storage for the years 1895-1971. Data abstracted from hypothetical multiple-purpose monthly operation (U.S.B.R.), partial impairments.

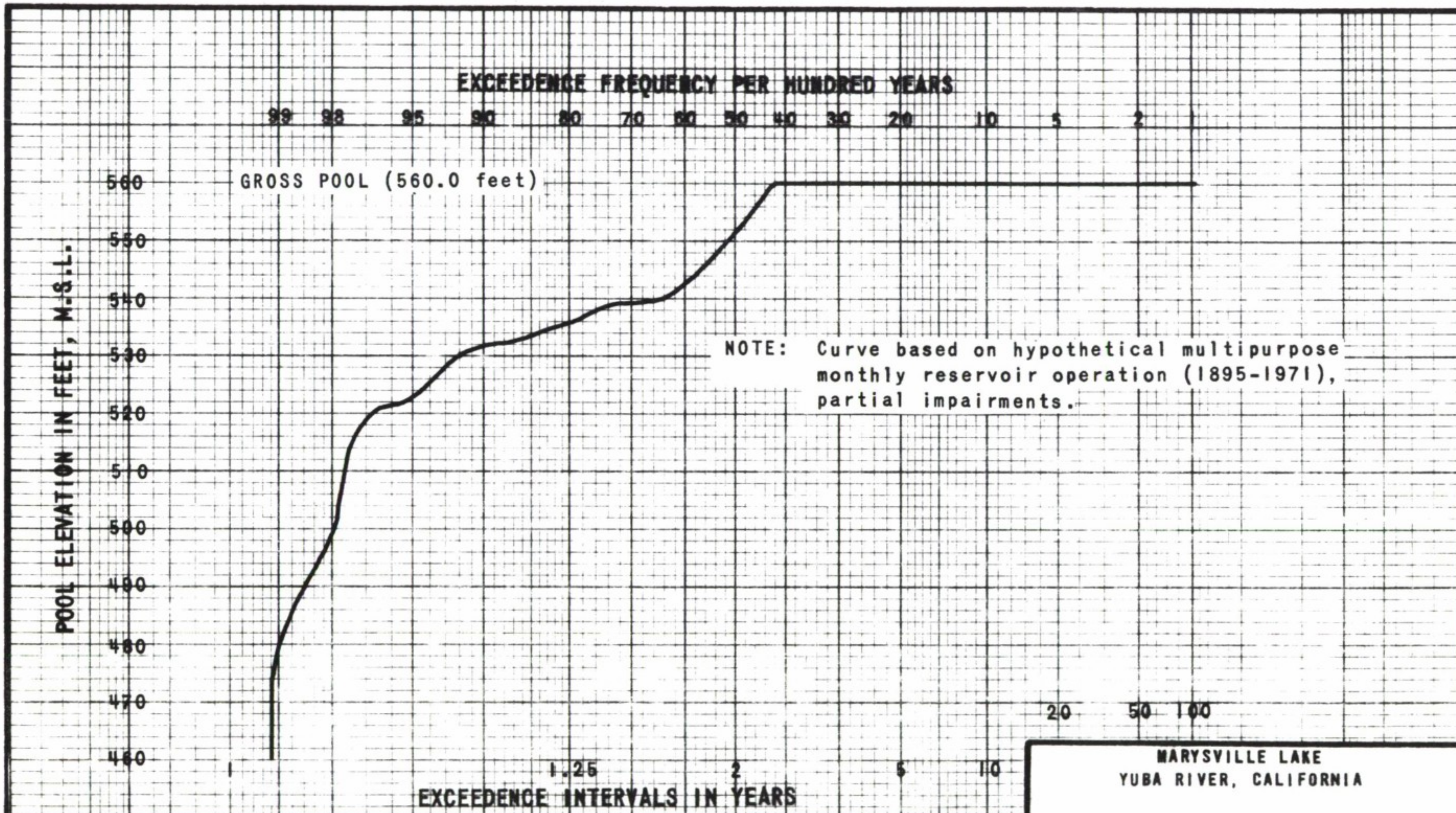
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

SEASONAL VARIATION OF
LAKE STORAGE FREQUENCY

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.D.M.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE F-14



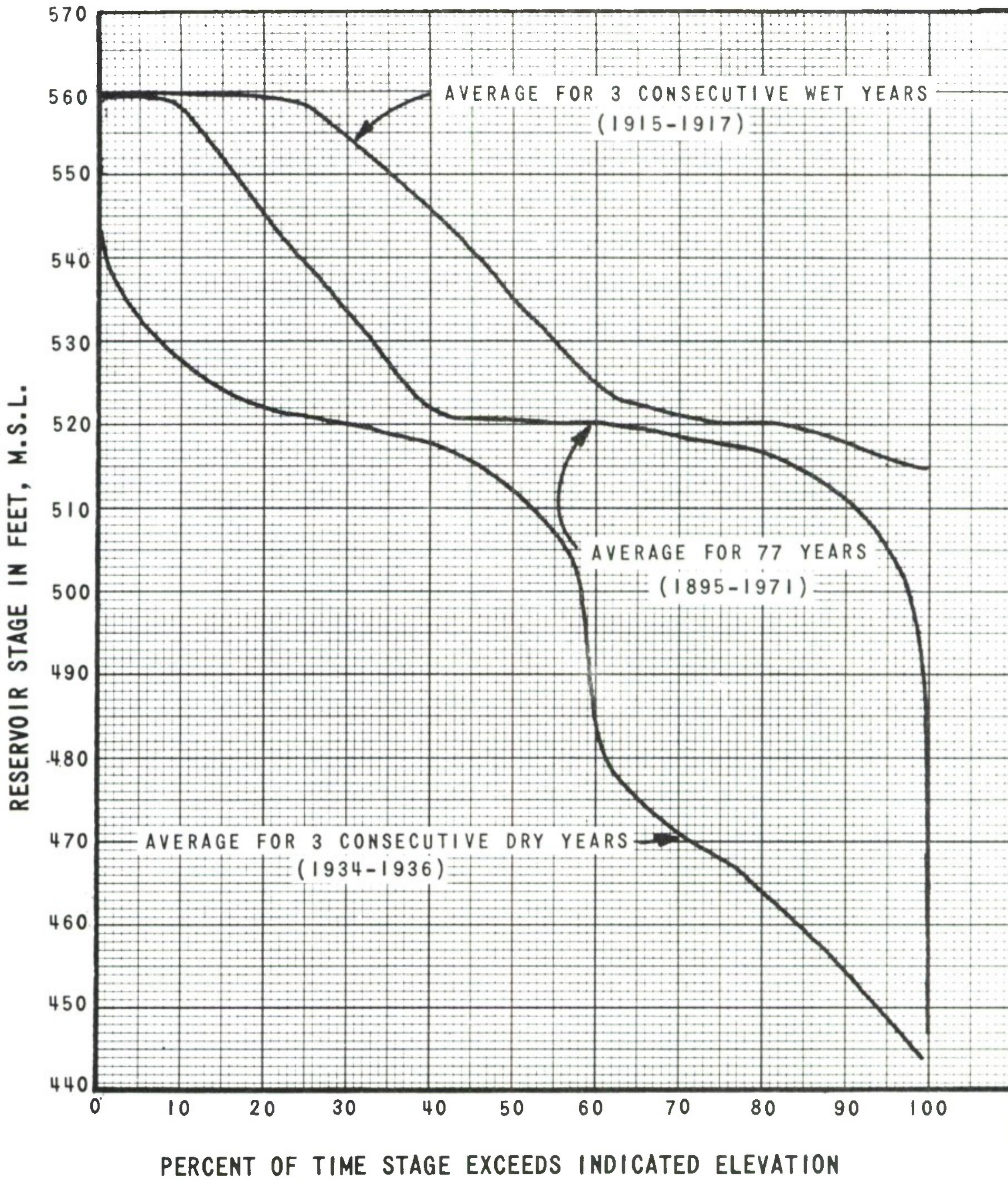
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

FREQUENCY OF MAXIMUM ANNUAL POOL ELEVATION

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.D.M.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE F-15



NOTE:

Curves represant percent of time givan stages are equaied or exceeded during the wettast 3 consecutiva years, the driest 3 consacutive years, and tha total record period, 1895-1971. Analysis based on hypothetical monthly multipla-purposa operation (U.S.B.R.), partial impairmants.

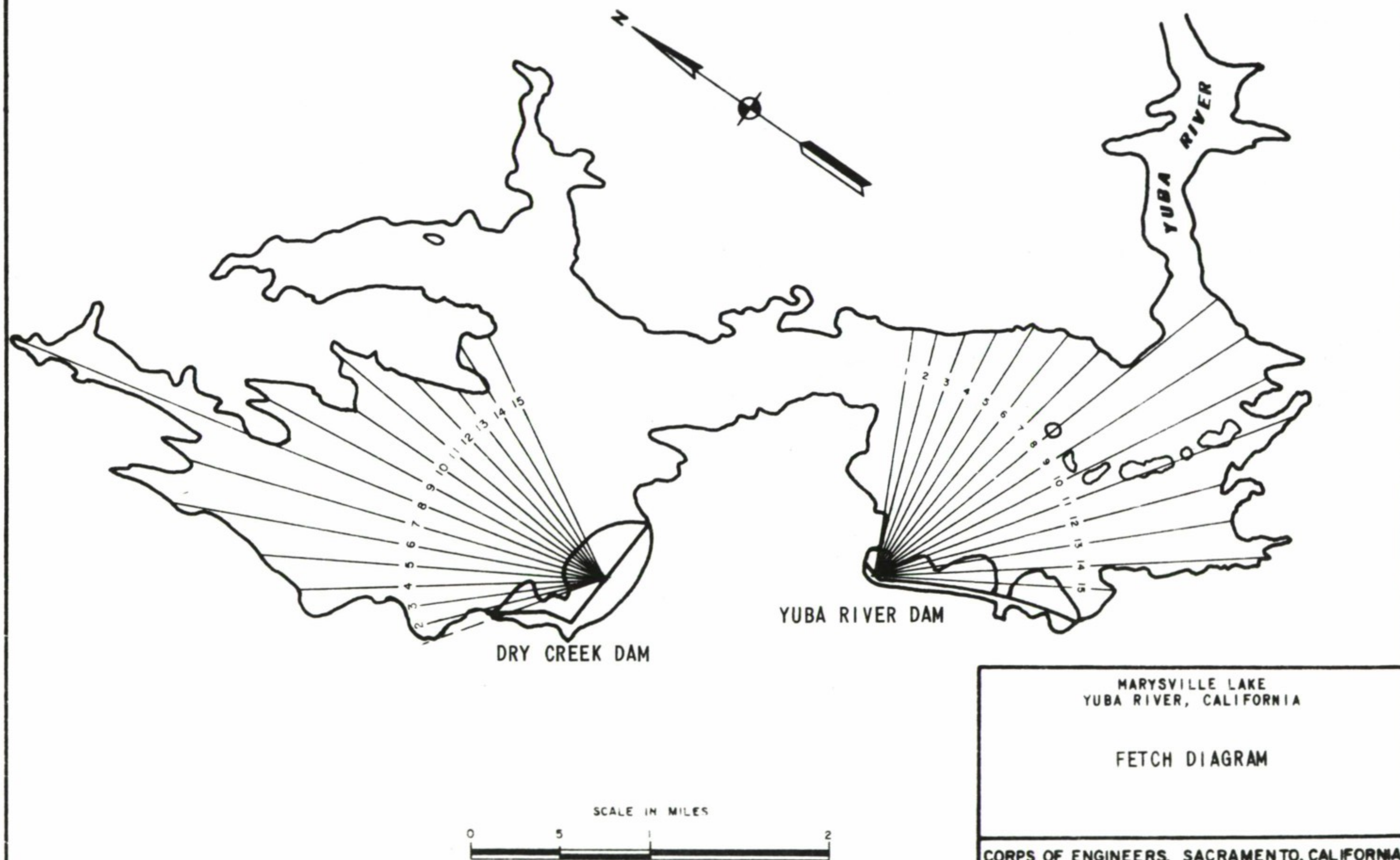
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

STAGE-DURATION CURVES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: C.D.M.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE F-16



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

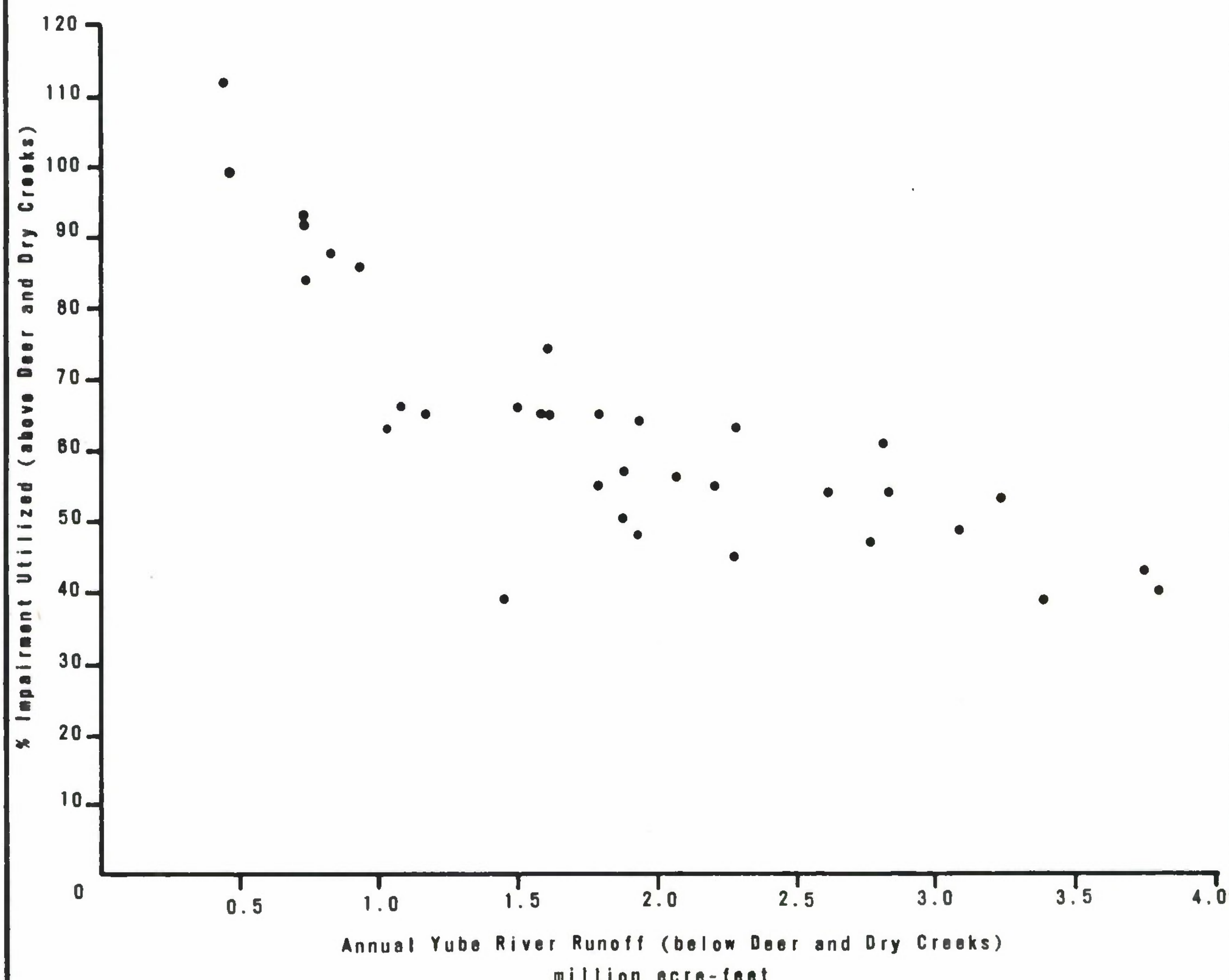
FETCH DIAGRAM

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.H.C.
Drawn: L.H.C.
Date: AUGUST 1975

FIGURE F-17

RELATIONSHIP BETWEEN ANNUAL YUBA RIVER STREAMFLOW AND PERCENT OF IMPAIRMENT UTILIZED (1922 - 1955)



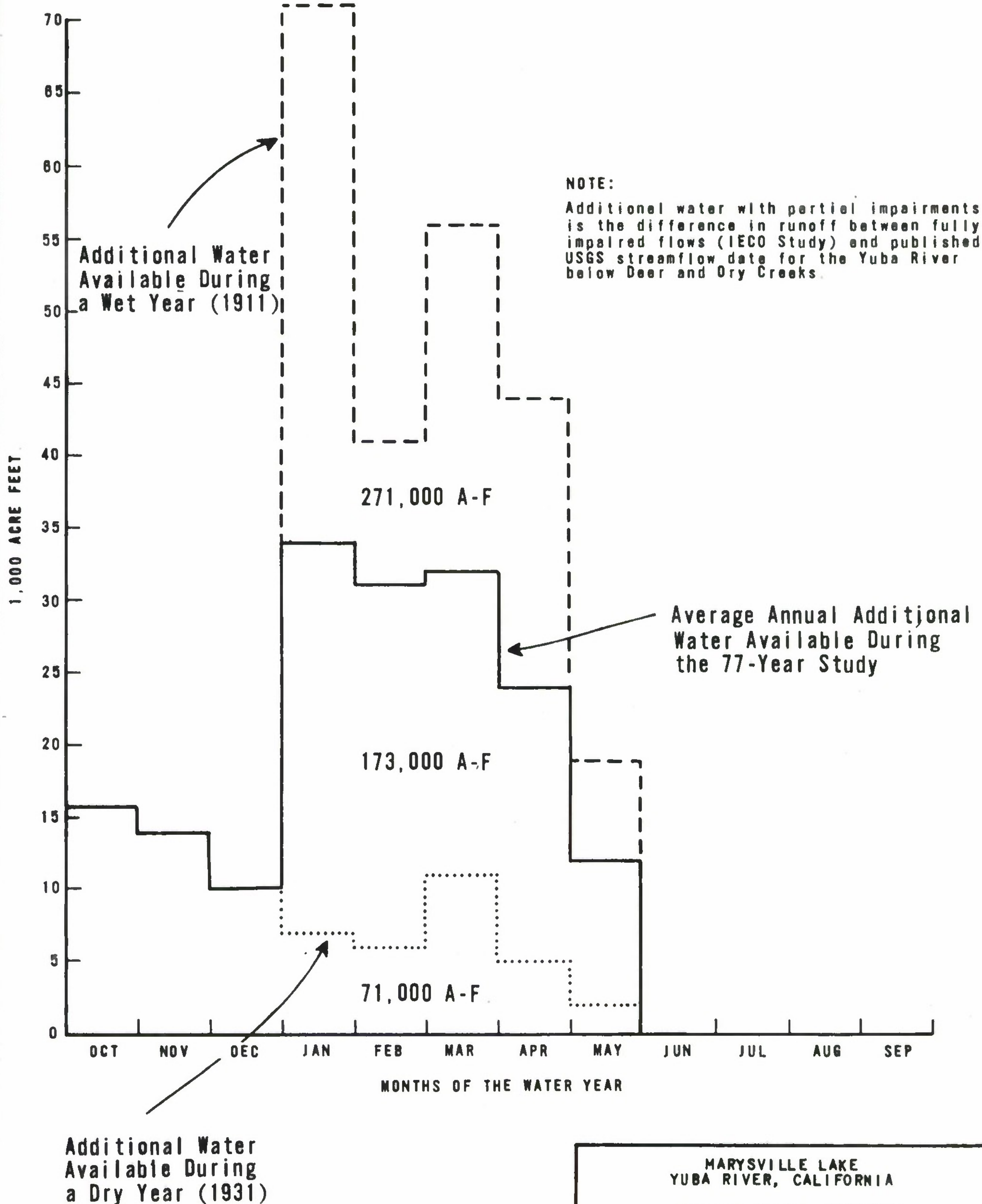
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

YUBA RIVER STREAMFLOW
VS
PERCENT IMPAIRMENT UTILIZED

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE F-18



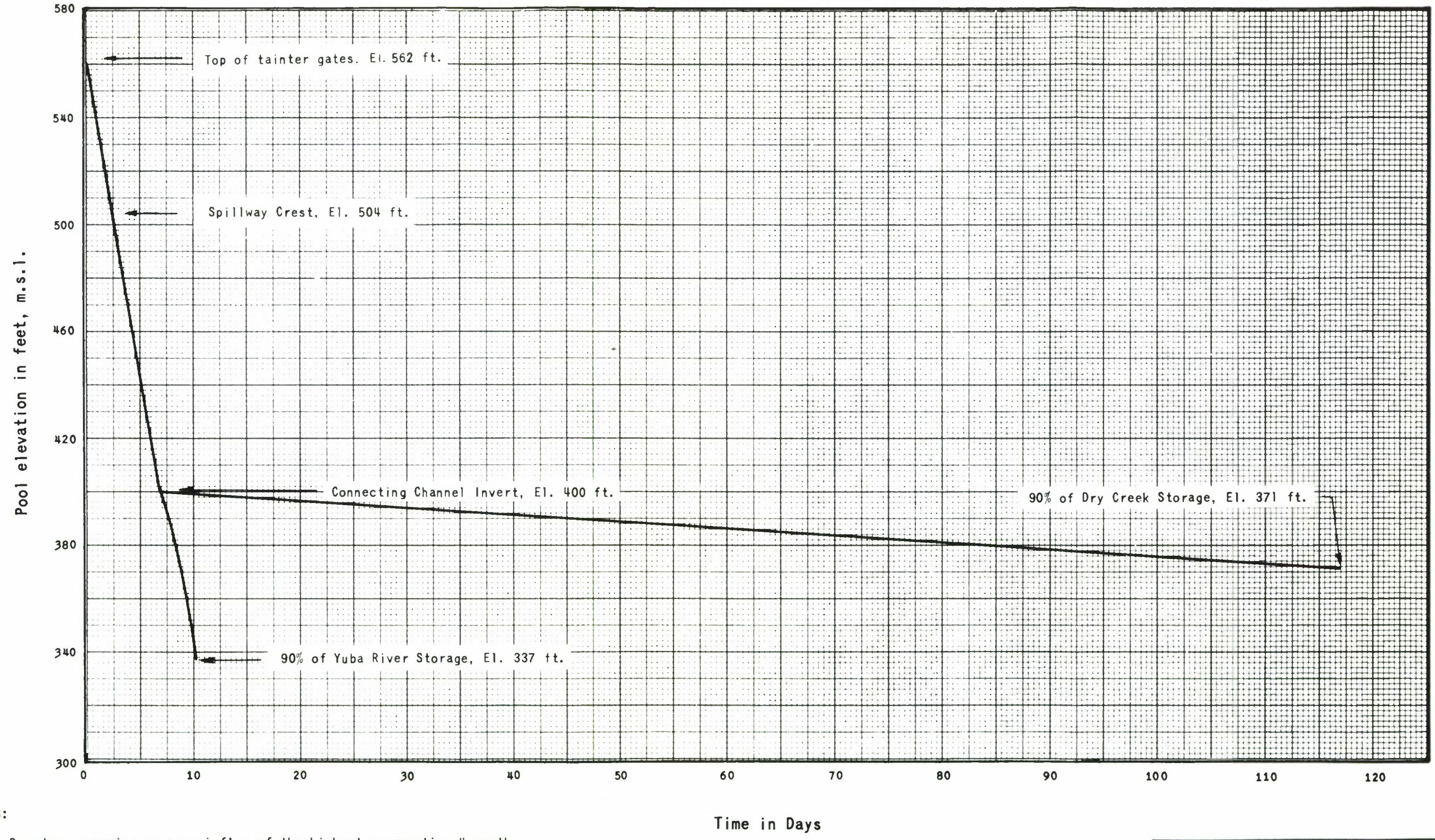
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

ADDITIONAL WATER WITH PARTIAL IMPAIRMENTS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE E-19



NOTES:

1. Drawdown assuming average inflow of the highest consecutive 4-month historical period -- 4,881 cfs for Yuba River
   -- 250 cfs for Dry Creek.
2. Outflow limited to 120,000 cfs above Spillway Crest.
3. Outflow limited to irrigation and power release between the elevations 504 and 400, with maximum release of 50,000 cfs.
4. Outflow limited to irrigation and 1/2 power release below elevation 400, with maximum release of 20,000 cfs.
5. Maximum outflow of 400 cfs in Dry Creek arm below elevation 400.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

EMERGENCY DRAWDOWN
MARYSVILLE LAKE

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: C.S.M.
Drawn: R.R.A.
Date: 3 JANUARY 1977

FIGURE F-20

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX G
WATER QUALITY AND HEAVY METALS

APPENDIX G
WATER QUALITY AND HEAVY METALS

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APPENDIX G

WATER QUALITY AND HEAVY METALS

1. Introduction. -

a. General. - Design Memorandum No. 1, Water Quality Control was approved by OCE on 20 May 1969. That DM described water quality in the project area as high and well suited to present and anticipated future use. Subsequently the project site has been changed from Browns Valley to Parks Bar, additional field data were gathered, and a number of related studies were conducted. Information obtained subsequent to preparation of DM No. 1 is summarized in this appendix.

b. Beneficial uses and criteria. - Project purposes are power, flood control, irrigation water supply, fish and wildlife enhancement, and recreation. Water quality criteria to be met to ensure that the latter three purposes can be achieved appear in Attachments A, B, and C to this Appendix.

The State of California, in its Water Quality Control Plan Report (4), has set beneficial uses of the Yuba River, from Englebright Dam to the Feather River, to be: irrigation and stock watering supply; power

NOTE: The numbers in parentheses refer to references cited at the end of this Appendix.

generation; contact and noncontact recreation; warm and cold freshwater fish habitat, migration, and spawning; and wildlife habitat. The State's water quality criteria necessary to ensure that these beneficial uses can be achieved appear in Attachment D. The State's criteria are incomplete for certain parameters; however, in such cases applicable criteria can be found in Attachment A, B, and C.

The California Department of Fish and Game and the U.S. Fish and Wildlife Service (FWS) have established maximum water temperature criteria for the Yuba River at its mouth for the maintenance of anadromous fish runs, and these are shown on Figures G-5 and G-7. (Minimum monthly water temperatures were established for study purposes.)

c. Studies. - In order to determine how well the project and its operation will allow the beneficial uses of the area's water to be met, the Corps is conducting the water quality monitoring programs and water temperature modeling studies described below. A special study on the presence of mercury, lead, and boron in the area was conducted by an A-E firm (see paragraph 5).

2. Historical Yuba River water quality. -

Water quality data collected by the California Department of Water Resources for the Yuba River at Marysville, on a monthly basis and

averaged for the 1966 through 1970 period, are shown in the next tabulation. The data show Yuba River water to have low salinity and low boron concentrations, fairly low amounts of dissolved nutrients (nitrogen and phosphorus) that typically cause eutrophication, and high concentrations of dissolved oxygen. These characteristics all indicate good water quality.

Historic Monthly Averaged
Water Quality in Yuba River at Marysville 1/

Month	Q acre-ft/mox10^3	EC umhos/cm	Boron mg/L	Na mg/L	HCO_3 mg/L	Tot. P mg/L	NO_3+Kjeldahl-N mg/L	Dissolved Oxygen mg/L	Temp °C	Turbidity Hellige Units
Jan	200	69	0.0	1.8	33	--	--	13	8.8	4.0
Feb	290	63	--	--	--	0.04	0.2	13	9.1	--
Mar	245	68	0.1	2.2	37	0.03	0.4	13	9.0	80
Apr	330	97	--	--	--	0.02	0.1	13	11	--
May	310	70	0.0	2.0	36	0.02	0.1	11	11	15
Jun	160	80	--	--	--	0.02	0.1	11	15	--
Jul	80	103	0.0	3.9	62	0.02	0.2	9.1	19	6.0
Aug	10	103	--	--	--	0.05	0.1	8.7	21	--
Sep	10	100	0.0	3.7	64	0.03	0.1	9.7	19	1.0
Oct	30	160	--	4.4	76	--	--	9.0	18	--
Nov	55	143	0.0	3.9	70	--	--	10	15	8.0
Dec	180	110	--	--	--	--	--	12	11	--
Min.		55	0.0	1.4	26	0.0	0.0	7.9	8.0	0.9
Avg.		89	0.02	3.0	53	0.03	0.2	11	14	20
Max.		160	0.1	4.4	76	0.08	0.7	13	25	80
No.		33	6	9	9	14	15	31	33	11

1/ From State Water Resources Control Board Basin Plan, August 1975. This was obtained from California Department of Water Resources Data.

The water quality of the Yuba during low flow periods has improved since the completion of New Bullards Bar Dam in 1970. The flow throughout the year is more constant, and the water is clearer and colder, with a lower mineral concentration.

The quality of water in a stream such as the Yuba depends primarily on the amount of flow, detention times in reservoirs, and the amounts of pollutants introduced into the water. The possible sources of pollution along the Yuba River are municipal or industrial (mining and lumber mills) wastes, erosion, and irrigation return flows. An earlier evaluation of mining and lumber operations showed that pollutants from these sources are not significant or are controlled to the extent that they do not lower the quality of the river water. This conclusion was partially based on the assumption that there are few remaining working mines in the area. Renewal of mining activity or substantial increases in logging activity could alter this situation.

Irrigation return flow enters the Yuba River from Dry Creek. In the summer a good proportion of the water in the creek is from return flow. Irrigation returns often contain high amounts of fertilizers, inorganic salts, and pesticides. The dense algal blooms often observed in Dry Creek in summer probably result from the nutrients in the return flow.

Quarries have operated in the lower Yuba River from time to time, and disturbed fines from such operations could be washed into the river by autumn and winter rains.

Ground water supplies in the project area are of good quality, with a few localized areas showing a relatively high mineral content.

Enforcement and implementation of current water-quality standards and issuance of improved and more detailed water quality standards for municipal and industrial discharges (California Water Resources Control Board), will aid in future maintenance of good water quality.

3. Marysville Lake water quality program. -

a. Description. - The Corps of Engineers is conducting a sampling and analysis program in the project area to determine current water quality. The program includes sampling of water quality and water temperatures in streams and existing reservoirs (Englebright and New Bullards Bar), and water quality in tailing pile leachate. The locations are shown on Figure G-1.

The stream water temperature sampling program, using continuous recorders, was initiated by the Corps in 1974. The recorder locations are:

North Yuba Above Slate Creek

Middle Yuba below Oregon Creek

Yuba River below Colgate Powerhouse

Yuba River at Daguerre Point

In addition to these stations, the U.S. Geological Survey (USGS) has been operating recorders for several years at four other locations (6), these being:

Yuba River below Englebright Dam

Yuba River near Marysville

Deer Creek near Smartville

North Yuba River below New Bullards Bar Dam

Locations of these recorders are also shown on Figure G-1. Data are being used in the water temperature modeling study discussed in paragraph 4.

Since October 1974 the Corps has been obtaining vertical profiles of water temperature in Englebright and Bullards Bar Reservoirs, and these data have been used in water temperature modeling studies. Since May 1975 vertical profiles of dissolved oxygen, electrical conductivity, and pH have also been obtained, with these data being used to diagnose the health of these reservoirs and therefore of the watershed. Secchi disk readings to determine sunlight penetration have also been obtained. Several grab samples for phytoplankton identification and enumeration were also taken, to get an indication of productivity occurring and also for an indication of what dominant specie can be expected in Marysville Lake.

The Corps has been conducting a grab sampling program at four stream sites since May 1975, for determining nutrient, organic, heavy metal, pesticide, and solids concentrations. Specifically, the parameters sampled for are biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia -N, nitrate -N, organic nitrogen, orthophosphate -P, total phosphorus, total and volatile suspended solids, dissolved solids, arsenic, mercury, lead, zinc, cadmium, copper, chromium, chlorinated herbicides, chlorinated biocides, and polychlorinated biphenols (PCB's). These samples are analyzed at the Corps South Pacific Division Laboratory. Tests were run on some tailing piles leachate to determine their potential to leach heavy metals upon inundation.

b. Results. - Representative vertical profiles from the existing nearby Englebright and New Bullards Bar Reservoirs, shown on Figure G-2, indicate that summer water temperatures reach 24°C at the lake surface, exhibit a thermocline at 50-70 foot depth, and remain about 7°C near the lake bottom throughout the summer. These conditions are similar to those predicted for Marysville Lake by the mathematical model, as shown in Figures G-4 and G-6. Representative dissolved oxygen profiles in the existing lakes, shown on Figure G-3, indicate that oxygen concentrations remain above 5.0 mg/L near the lake bottoms during periods of thermal stratification, indicating that neither inflows of organic loads and nutrients nor phytoplankton blooms are excessive. The dissolved oxygen observations can be extended to Marysville Lake if pollutant load input does not occur in the stream reach between the existing reservoirs and Marysville Lake. If these historic temperature and dissolved oxygen profiles are extended to Marysville Lake, and it is assumed that pumpback operation does not cause a drastic change to these regimes, then a cold water lake fishery should thrive according to the criteria shown in Attachment B, Figure B-1.

Secchi disk observations, shown in the tabulation below, indicate that suspended sediment runoff in winter-spring generally produce Secchi disk depths of 8-14 feet. After inflows are reduced and settling time afforded by the reservoir occurs, the summer-fall Secchi disk depths are

about 15-25 feet. These data indicate that water clarity at Marysville Lake should be highly satisfactory for water-contact recreation, as shown in Attachment C, and for fishery, if related to the suspended solids concentrations of Attachment B.

Secchi Disk Readings (Feet)

Date	Englebright Res.	New Bullards Bar Res.
19 May 75	8	16
23 Jun 75	NR	21
17 Jul 75	22	25
26 Aug 75	25	12
17 Sep 75	18	NR
28 Oct 75	16	20
21 Nov 75	NR	NR
17 Dec 75	10	7
22 Jan 76	12	8
24 Feb 76	14	10
26 Mar 76	11	10
30 Apr 76	22	23
26 May 76	19	21
25 Jun 76	10	20
30 Jul 76	16	15
20 Aug 76	16	18
23 Sep 76	24	21
22 Oct 76	19	21
19 Nov 76	25	NR
22 Dec 76	22	NR

The phytoplankton data at Englebright and New Bullards Bar Reservoirs, shown in the next tabulation, indicate that excessive algal blooms were not occurring at the time of sampling and that Flagellates can be expected to be the dominant specie in the Marysville Lake. The

expected magnitudes of phytoplankton growths in Marysville Lake are not expected to cause a visual nuisance, and the expected specie will not cause an odor problem. These two parameters will, thus, not affect recreation use.

Phytoplankton Identification and Enumeration, Cts/ml.

Date	Englebright Res.		New Bullards Bar Res.
	0	Blue-greens	84
2 Aug 76	84	Greens	0
	230	Flagellates	210
	21	Diatoms	0
	335	Total	294
	21	Blue-greens	0
14 Sep 76	63	Greens	0
	1,300	Flagellates	430
	21	Diatoms	0
	1,405	Total	430

Laboratory results for stream and tailings water quality sampling in the spring of 1976 are shown in the next tabulation.

The salinity data (either EC of paragraph 2 or total dissolved solids (TDS) of the next tabulation) indicate water of excellent salinity quality, and the irrigation criteria of Attachment A are easily met. This water can be classified as low salinity hazard - low sodium hazard irrigation water.

CHEMICAL ANALYSIS OF WATER SAMPLES[1]

Stream Sampling

Reported as milligrams per liter

Laboratory No.	Location	Date Sampled (1976)	TSS	VSS	TDS	Organic As (As)	Organic NH3 (N)	Organic N (N)	Organic NO3 (N)	Organic PO4 (P)	Total P (P)	COD	Hg (Hg)	Cd (Cd)	Pb (Pb)	Zn (Zn)	Cu (Cu)	Cr (Cr)
PC-3113	Deer Creek	27 May	(a)	(a)	90	.0012	.05	.24	.033	.003	.03	8.7	.0001	.0002	.005-	.026	0.01	.01-
PC-3114	Deer Creek	2 June	2.5	0.8	102	.0012	.02	.21	.033	.003-	.01	5.2	.0001-	.0002	.007	.008	0.01	.01-
PC-3115	Dry Creek	13 May	8.4	2.8	166	.0014	.04	.36	.044	.006	.01	12.1	.0003	.0001-	.005-	.005-	0.01-	.01-
PC-3116	Dry Creek	2 June	7.4	2.2	190	.0010	.04	.65	.037	.015	.03	4.0	.0003	.0001-	.005	.005-	0.01-	.01-
PC-3117	South Yuba River	27 May	3.2	1.6	64	.0003	.01-	.07	1.70	.003-	.01	21.1	.0001-	.0001-	.005-	.008	0.01-	.01-
PC-3118	South Yuba River	2 June	1.0	0.8	70	.0007	.03	.04	.049	.003	.01	11.3	.0001-	.0001-	.005-	.011	0.01-	.01-
PC-3120	Middle Yuba at Rice Crossing	27 May	7.2	2.4	64	.0010	.01	.14	.260	.003-	.003	0.3	.0001-	.0001-	.006	.013	0.01-	.01-
PC-3121	Middle Yuba River	2 June	3.2	1.4	50	.0005	.02	.07	.064	.006	.01	2.9	.0009	.0001	.007	.005-	0.01-	.01-
PC-3119	Yuba River at Rose Bar		2.2	0.6	52	.0005	.01	.16	.042	.003	.01	2.4	.0002	.0005	.005	.005-	0.01-	.01-
PC-3122	Parks Bar Site		2.0	0.8	58	.0006	.01-	.01	.072	.003	.01	3.8	.0001-	.0004	.006	.005-	0.01	.01-

Tailings Sampling

Laboratory No.	Location	Date Sampled (1976)	Sampling depth, ft.	Wht. of tailing added, gm.	Vol. of water added, ml	Hg (Hg)	Cd (Cd)	Pb (Pb)	Zn (Zn)	Cu (Cu)	Cr (Cr)
	20-Day Shake Test										
PC-3123	50' S. of Yuba River at Rose Bar	2 June	1	485	615	.0001	.0003	.009	.018	0.01	.01-
PC-3124	300' S. of Yuba River at Rose Bar	2 June	1	392	685	.0001-	.0001-	.005-	.008	0.02	.01-
	30 Day Shake Test										
PC-3125	2500' U/S of Parks Bar Bridge	13 May	1	410	700	.0005	.003	.034	.072	0.03	.01-
PC-3126	3000' U/S of Parks Bar Bridge	13 May	1	461	665	.0001-	.002	.005	.024	0.01-	.01-
	pH1										
PC-3127	50' S. of Yuba River at Rose Bar	2 June	1	445	600	.0001-	.011	.009	.84	0.77	.01-
PC-3128	300' S. of Yuba River at Rose Bar	2 June	1	458	660	.0001-	.010	.008	.14	2.7	.01-
PC-3129	2500' U/S of Parks Bar Bridge	13 May	1	451	625	.0001-	.0003	.041	.032	0.04	.01-
PC-3130	3000' U/S of Parks Bar Bridge	13 May	1	404	760	.0001-	.002	.005-	.045	0.05	.01-

(a) Contaminated with paper from bottle lid

[1] South Pacific Division Laboratory.

The boron and arsenic data indicate that the irrigation criteria of Attachment A will be met.

The organic load data is represented by COD. The COD data is rather high on occasion in Dry Creek and the South Yuba River. However, in comparing the load from South Yuba River with historic dissolved oxygen profiles of Englebright Reservoir, it does not appear that these loads will lower the oxygen concentrations in Marysville Lake below those shown to be needed by a resident lake fishery in Figure B-1.

The nutrient data, consisting of ammonia, nitrate, and organic nitrogen, and dissolved and total phosphorus, while sparse, does not indicate that excessive phytoplankton growths will occur. The data suggest that the South Yuba River may contain a higher nutrient concentration, and on-going monitoring will clarify this. The data show that Dry Creek has somewhat high values of organic nitrogen. This is in line with what a visual inspection of Dry Creek shows, as phytoplankton growths are fairly abundant near the shoreline, and a fair amount of attached algae occurs on stream-bottom rocks. Values of nitrogen and phosphorus load in Deer Creek are low, although the stream carries the secondary wastewater effluent from Nevada City. Phosphorus is in low concentrations at all sites sampled. Excessive biostimulation by nutrients is not expected, and nuisance blooms affecting recreation and demands on oxygen from decaying blooms should not occur in Marysville Lake.

The heavy metals tested for in the water column are copper, lead, mercury, zinc, cadmium, and chromium (all valences). The concentrations shown do not exceed the criteria needed either for irrigation, as shown in Attachment A, or for fish and wildlife habitat, as shown in Attachment B. Materials from some tailings piles were subjected to both acidic conditions and long-term leaching, to see if heavy metals could be extracted into the test water. The zinc and copper extracted from the 2 June 1976 Rose Bar samples, when placed under acidic conditions, were in rather high concentrations, but not in the same samples when placed under long-term leaching in neutral pH water. This indicates the metals are present, but will be released only under certain conditions. However, the concentrations are not cause for concern because of the lake water available for dilution, and the fact that the heavy metals will be released at a much slower rate than occurred in the laboratory under acidic conditions.

BOD data are shown in the next tabulation. BOD represents the soluble, easily biodegradable organic load, and the magnitudes are not excessive.

Biochemical Oxygen Demand (5-day), mg/L

Location	13 May 76	2 Jun 76	2 Dec 76
Yuba River at Parks Bar	2.1	1.1	2.6
Middle Yuba River at Rice Crossing	NR	0.9	2.5
South Yuba River at Bridgeport	NR	1.1	1.6
Dry Creek at county bridge	3.4	4.3	2.4

This BOD data should be analyzed with the COD data previously given, to determine the effects of oxygen demand upon Englebright and New Bullards Bar Reservoirs' dissolved oxygen profiles. As previously stated, these loads are not expected to have an adverse effect upon dissolved oxygen concentrations in Marysville Lake.

The pesticide data collected to date, while sparse, is from the Middle Yuba River and is shown in the next tabulation. This part of the program is a general survey of the presence of the pesticide groupings of chlorinated herbicides, chlorinated biocides, and PCB's. The herbicide group does not exceed the fish and wildlife criteria of Attachment B, but the biocides and PCB's both exceed this criteria. Further pesticide sampling is being done. If considered a problem, pesticide control could be undertaken by regulatory agencies.

	Middle Yuba River at Rice Crossing	
Date Samples	29 May 1976	2 June 1976
CHLORINATED PHENOXY ACID HERBICIDES		
Dicamba, reported as ug/L	--	0.11
ORGANOHALOGEN BIOCIDES		
P, P; DDT, reported as ug/L	--	0.03
Methoxyclor, reported as ug/L	0.09	--
POLYCHLORINATED BIPHENOLS (PCB's)		
Aroclor 1242, reported as ug/L	0.44	0.44
Aroclor 1254, reported as ug/L	--	0.02

The discussions above, as to whether given parameters meet or exceed beneficial uses, will generally apply to the State's "Objectives for Inland Waters," shown in Attachment D. The State's objectives were not directly used in the discussion because they are mostly not separated into criteria for the various beneficial uses, and because many of their objectives are qualitative rather than quantitative at this time.

4. Mathematical model of water temperatures. -

a. Methodology. - This study is being conducted by the U.S. Army Corps of Engineers Waterways Experiment Station to determine if the Marysville Lake project, using a selective withdrawal structure, can satisfy downstream water temperature objectives set by fish and

wildlife agencies. A one-dimensional mathematical model, which had been previously developed by the Waterways Experiment Station and the University of Texas (WESTEX model), and which has been used for other pre-impoundment temperature studies, is being used for simulation and prediction of temperatures in Marysville Lake and the afterbay. Afterbay temperatures are routed downstream to the mouth of the Yuba River using Edinger's temperature model (2) for a well-mixed stream with uniform depth and velocity. A physical hydraulic model is being used for study and description of the hydrodynamic response of the lake to pumped-storage hydropower operations. The physical model, constructed to a distorted-scale of 1:1600 horizontal and 1:160 vertical, simulates the dynamic, unsteady-state, density stratified flows through Marysville Lake and the afterbay (reregulating) pool. Information from the physical model is used to determine the amount of entrainment which occurs with pumpback at different elevations and its effects upon the lake's thermal stratification, and to modify existing and develop new algorithms for the mathematical models.

The mathematical models allow simulation of the heat exchange characteristics so that the thermal regimes within and downstream of the lake can be determined for three hydrologic and meteorologic conditions and various pumped-storage hydropower operations. Hydrologic conditions from 1962 were used to represent a normal year, from 1934 for a dry year, and from 1942 for a wet year. Yearly reservoir operations have been modeled with pumpback through the port of withdrawal and with pump-

back through a single low-level port to determine which would have the least effect on vertical mixing and warming of the colder hypolimnion waters. Two pumped-storage hydropower installations are being studied, one with a 900 MW capacity and one with 2,250 MW capacity.

The purpose of these studies for the Phase I GDM are solely to determine if operation of the project with selective withdrawal capability will allow downstream temperature objectives to be met. Additional temperature studies will be conducted during preparation of subsequent design memorandums to assist in optimizing design of the selective withdrawal structure for operational effectiveness, cost, and maintenance. The existing physical model would be utilized for these studies with some minor modifications.

b. Results. - Results of the 900 MW capacity study indicate that the project will meet the band of temperature objectives set for the mouth of the Yuba River for all three hydrologic years studied.(5) Satisfactory results were obtained with pumpback occurring either back through the port of withdrawal or through a single low-level port. Pumpback through the port of withdrawal was preferable with regard to minimizing vertical mixing and maintaining the cold-water resource of the lake's hypolimnion. The predicted temperature profiles in the lake (with pumpback occurring through the withdrawal port) and the predicted temperatures at the mouth of the Yuba River for the average hydrologic year 1962 are shown in Figures G-4 and G-5, and for the dry hydrologic year 1934 in

Figures G-6 and G-7. The predicted temperature profiles for Marysville Lake compare fairly well, as regards surface and bottom temperatures and depth to the thermocline, to historic temperature profiles of Englebright and New Bullards Bar Reservoirs shown in Figures G-2. Thus, pumpback operation with a 900 MW powerplant does not appear to have a significant effect upon the temperature characteristics of the lake.

As can be noted from Figures G-4 and G-6, with the 900 MW powerplant there is always cold water of 5-6°C in the hypolimnion of the project lake throughout the summer. The selective withdrawal flows and temperatures from the different elevations must be such that the warming provided by afterbay detention time and stream travel allows the temperature objective band at the Yuba River mouth to be met. This has been achieved, as shown in Figures G-5 and G-7, except in October of the dry year. As mentioned, there is still cold water of 5-6°C available in the lake throughout the summer to maintain this downstream objective band. It should be noted that the predicted downstream temperatures for October of the dry year will be better for the anadromous fish than those which occurred historically in October on the average, as shown in the tabulation in paragraph 2.

Tests with a 2,250 MW pumped storage powerplant are currently underway. Preliminary results indicate that temperature objectives can be met with this installation. As previously stated, additional temperature studies will be conducted in conjunction with subsequent Design Memorandums to optimize design of the selective withdrawal system.

5. Mercury, lead, and boron sampling program. -

The Corps of Engineers contracted with BEAK Consultants, Inc., in December 1975 to conduct a study (1) to determine the levels of mercury, lead, and boron in water, sediments, plants and animals in the project area and the probability that inundation of gold mining dredge tailings by the project and excavation of the riverbed for construction might release undesirable amounts of these elements into the environment.

The sampling locations on Yuba River were at Rose Bar, upstream of the main concentration of dredge tailings, and at a site near Marysville below the dredge tailings. Samples were also taken from Long Bar and Gold Field Ponds in the tailings area and from Timbuctoo Pond upstream of the dredge tailings. Sampling stations are shown on Figure G-8. (The Gold Field site was used for fish samples only.) Ponds were sampled because of the relative immobility of organisms and sediments in the ponds, as compared to those in the river, thereby representing good models to determine potential long-range problems.

In addition, BEAK was supplied with eight composite samples of sands collected by a separate contractor to the Corps of Engineers between May and September 1975, from four 48" core samples on Long Bar. In order to determine the tendency of these sediments to leach mercury, lead and boron, a 1:5 extraction with water was conducted by the BEAK analytical laboratories. The literature search and field testing indicated the following:

a. Mercury. - Mercury was present in detectable amounts, 0.31 parts per billion (ppb), at only one sample site, the pond at Timbuctoo Bend, and in only one of the three samples taken at that site. The lack of occurrence of mercury in detectable concentrations in water samples is consistent with statements in the literature concerning the rapid removal of mercury from water by adsorption, sedimentation, and biological precipitation. The 0.31 ppb detected in one water sample from the pond at Timbuctoo Bend is only slightly above detectable limits and is considerably lower than the 2.2 ppb reported for the headwaters of the Feather River near Portola.(3)

The concentrations of mercury in the sediment samples at Rose Bar and Long Bar Pond were above the California average (20-40 ppb mercury).(1) The Marysville sediment samples showed considerably lower concentrations.

In general, algae samples taken from Timbuctoo and Long Bar Ponds showed higher mercury content than the samples taken from Yuba River.

The aquatic macrophytes (large bodied aquatic plants) tested were bullrush and cattail. These samples had mercury levels comparable to the background level in California, which is less than 100 ppb for most grains, fruits, and vegetables.

The willow leaf samples exhibited higher mercury concentrations at the downstream sites at Long Bar and near Marysville than at the upstream sites at Rose Bar and Timbuctoo.

The following tabulation summarizes the mercury residues found in the water, sediment, and plant samples tested.

	Ponds (ppb)			Yuba River (ppb)	
	Timbuctoo	Long Bar 1	Gold Field	Rose Bar	Marysville
Water (total)	0.31	<0.25	--	<0.25	<0.25
	<0.25	<0.25	--	<0.25	<0.25
	<0.25	<0.25	--	<0.25	<0.25
Sediment	1.20 2/	220	--	360	130
	0.77 2/	170	--	210	87
	0.69 2/	120	--	64	54
Algae	270	690 1/	--	190	--
	220	--	--	150	--
	160	--	--	130	--
Macrophytes	73	150	--	--	--
	73	59	--	--	--
	55	50	--	--	--
Willow leaves	53	210	--	91	250
	<50	130	--	50	170
	<50	100	--	<50	<50

1/ Samples pooled because of small sample size.
2/ Results are from elutriate test.

Mercury residues found in the fish samples collected from Long Bar and Gold Field Ponds are shown in the next tabulation. Mercury residues in the squawfish, the catfish, and two of the blackfish were slightly above the U.S. Food and Drug Administration's limit of 0.5 parts per

million (ppm). Two of the Sacramento suckers had mercury residues in their tissues equal to or higher than the limit. Mercury concentrations in the tissues of the suckers increased with the size of the individual fish; however, no such size-content relationship is evident in the other species sampled.

Fish	Long Bar (ppm)	Gold Field (ppm)
Sacramento squawfish	0.60 (14.75) 1/	0.21 (11.5) 0.29 (10.75) 0.19 (10.5) 0.26 (8.0) 0.20 (7.75) 0.38 (7.50)
Sacramento sucker		0.50 (18.0) 0.78 (17.5) 0.26 (14.25) 0.19 (14.25) 0.092 (13.75)
White catfish	0.62 (9.0)	
Green sunfish	0.18 (6.5)	
Bluegill	0.25 (6.5)	
Sacramento blackfish	0.51 (15.75) 0.59 (15.25) 0.38 (14.75)	

1/ Number in ( ) indicates length of fish in inches.

The concentrations of mercury in water, sediments and biological materials were not greater than concentrations measured in comparable areas in California, and while some fish exceeded U.S. Food and Drug Administration (FDA) guidelines for human consumption, this cannot be

considered unusual in light of measurements made elsewhere in California.(1)

Results of tests of the Long Bar core sand samples are as follows:

Sample	Depth (ft)	Mercury (ppm)
2B - 14 top	0-36	0.0012
2B - 14 bottom	36-74	0.00077
2B - 15 top	0-41-1/2	<0.00025
2B - 15 bottom	41-1/2-76	<0.00025
2B - 16 top	0-25	0.00069
2B - 16 bottom	25-47	<0.00025
2B - 17 top	0-35	<0.00025
2B - 17 bottom	35-66	<0.00025

Three of the mercury determinations indicated detectable levels with two of these values coming from core 2B - 14. The highest value obtained was 0.0012 ppm, which is lower than the 0.0022 ppm reported for the headwaters of the Feather River near Portola. These values cannot be considered extraordinarily high as compared to the surface water results, especially in light of the vigorous extraction method.

b. Lead. - No water samples contained detectable levels of lead. This finding is consistent with the low solubilities of most lead compounds and also with the study by the Federal Water Pollution Control Administration of water samples taken from the Sacramento River system from 1962-1967.

Lead was present in detectable amounts in sediment samples taken from Long Bar Pond and the site near Marysville. Samples from both sites had lead concentrations considerably higher than the 0.010-0.015 ppm average for rural soils and the earth's crust.

Lead was also present in detectable concentrations in most of the algae sampled, and the residue levels were generally higher than soil levels.

Lead was not detected in bullrushes gathered from Timbuctoo Pond, but was observed in cattails gathered from the Long Bar Pond. Concentrations of residues in the cattail samples closely matched those of the sediment samples from that site.

Low lead levels were detected in the willow leaf samples from the Long Bar site and along the Yuba River at Rose Bar. Levels in samples from the downstream site near Marysville were considerably higher, exceeding the lead levels in sediments from that area.

None of the fish taken from Long Bar and Gold Field Ponds contained detectable concentrations of lead.

The following tabulation summarizes lead residues found in the samples tested.

	Ponds (ppb)			Yuba River (ppb)	
	Timbuctoo	Long Bar 1	Gold Field	Rose Bar	Marysville
Water (total)	<0.01	<0.01	--	<0.01	<0.01
	<0.01	<0.01	--	<0.01	<0.01
	<0.01	<0.01	--	<0.01	<0.01
Sediment	<0.01	12.0	--	<2.5	5.5
	<0.01	9.7	--	<2.5	4.6
	<0.01	7.5	--	<2.5	<2.5
Algae	19.0	20.0 1/	--	4.3	--
	9.0	--	--	3.8	--
	8.8	--	--	<1.5	--
Macrophyte	<2.5	<14.0	--	--	--
	<2.5	< 3.0	--	--	--
	<2.5	< 2.4	--	--	--
Willow leaves	<2.5	3.0	--	4.3	32.0
	<2.5	3.0	--	4.3	13.0
	<2.5	< 1.5	--	1.8	6.3
Fish	--	< 0.25	<0.25	--	--
	--	(7 samples)	(11 samples)	--	--
	--			--	--

1/ Samples pooled because of small sample size.

The concentrations of lead measured were low and comparable with values measured in other unurbanized areas in California.

Results of tests of the Long Bar core sand samples are as follows:

Sample	Depth (ft)	Lead (ppm)
2B - 14 top	0-36	<0.01
2B - 14 bottom	36-74	<0.01
2B - 15 top	0-41-1/2	<0.01
2B - 15 bottom	41-1/2-76	<0.01
2B - 16 top	0-25	<0.01
2B - 16 bottom	25-47	<0.01
2B - 17 top	0-35	<0.01
2B - 17 bottom	35-66	<0.01

All lead levels were below the level of detection, as was found for surface waters.

c. Boron. - STORET data from 1960 to 1966 showed concentrations of boron in the Yuba River near Marysville ranging from 0 to 100 ppb and averaging 15.38 ppb. Samples collected upstream on the Yuba River near Smartville during the same period also showed values ranging from 0 to 100 ppb with an average of 13.73 ppb. These boron levels are well below the national average of 101 ppb and are considerably less than the averages for the lower Sacramento River. The samples tested by BEAK contained less than 100 ppb of boron. This reflects the very low boron content of Sierra-type soils in northern California and is below the level of toxicity for most plants. The concentrations of boron in water were substantially below the limits recommended for irrigation water (400 ppb).

Boron was present in detectable concentrations in all three sediment samples taken from Long Bar, in two of the samples from Rose Bar, and in one of the samples from the site near Marysville.

Algae taken from ponds at Timbuctoo Bend and Long Bar showed some tendency to accumulate boron. Samples from Yuba River at Rose Bar did not show this tendency but matched the boron concentrations of surrounding sediments.

The aquatic macrophytes sampled from the ponds at Timbuctoo Bend and Long Bar had low but detectable concentrations of boron.

Boron residues were present in all samples of willow leaves with highest concentrations observed in willows growing near the ponds at Timbuctoo Bend and Long Bar. Boron is a necessary micronutrient for the growth and development of many higher plants and is toxic to only very sensitive species, except in high concentrations.

The following tabulation lists the boron residues detected in the samples tested:

	Ponds (ppb)			Yuba River (ppb)	
	Timbuctoo	Long Bar 1	Gold Field	Rose Bar	Marysville
Water (total)	0.1	<0.1	--	<0.1	<0.1
	0.1	<0.1	--	<0.1	<0.1
	0.1	<0.1	--	<0.1	<0.1
Sediment	--	5.6	--	3.4	3.7
	--	5.3	--	2.1	<2.0
	--	2.2	--	<2.0	<2.0
Algae	16.0	11.0 1/	--	2.7	--
	7.2	--	--	2.5	--
	5.0	--	--	<2.5	--
Macrophyte	3.9	6.5	--	--	--
	3.3	6.2	--	--	--
	3.2	5.8	--	--	--
Willow leaves	46.0	72.0	--	22.0	32.0
	36.0	33.0	--	21.0	13.0
	23.0	10.0	--	20.0	6.3
Fish	--	0.25 1/	2.5 1/	--	--
	--	(7 samples)	(11 samples)	--	--
	--			--	--

1/ Samples pooled because of small sample size.

Results of tests of the Long Bar core sand samples are as follows:

Sample	Depth (ft)	Boron (ppm)
2B - 14 top	0-36	0.01
2B - 14 bottom	36-74	0.02
2B - 15 top	0-41-1/2	<0.01
2B - 15 bottom	41-1/2-76	<0.01
2B - 16 top	0-25	<0.01
2B - 16 bottom	25-47	0.01
2B - 17 top	0-35	0.02
2B - 17 bottom	35-66	0.01

Five of the boron samples showed levels slightly above the levels of detection, but levels could not be considered injurious to agricultural plants.

6. Discussion. -

It is clear from data at Englebright and New Bullards Bar Reservoirs that Marysville Lake would tend to develop a strong stratification from April through November. The mathematical model study at the Waterways Experiment Station, calibrated with thermal profile data from Englebright and New Bullards Bar, indicates that the pumpback power operation would not destratify the reservoir.(5) Results from the 900 MW study show that the downstream temperature objects can be met. Results from the 2250 MW study are not available for this draft, but will be included in the final Phase I GDM.

Data on organic and nutrient loads indicate that the eutrophication potential in Marysville Lake is low, and phytoplankton growth would not be significant. Direct nutrient transport by streams into the reservoir would be low. Dissolved oxygen profile data from Englebright and New Bullards Bar indicate that relatively high levels of dissolved oxygen are maintained in their hypolimnions throughout the year, and in the absence of additional organic loads the same may be expected in Marysville Lake.

The relatively high transparency indicated by Secchi disk data from Englebright and New Bullards Bar implies that turbidity and suspended sediments would not be a problem in Marysville Lake.

Heavy metal and pesticide data show no cause for concern, although future thoughts on pesticide control in the watershed may be warranted.

The monitoring program is continuing, and the results will appear in future DM's. A construction and project water quality monitoring program will be discussed in the Phase II GDM.

APPENDIX G

REFERENCES CITED

(1) BEAK Consultants, Inc., Mercury, Lead and Boron Levels in the Vicinity of the Marysville Lake, California, Project, March 1976.

(2) Edinger, J.E. and Geyer J.C., "Heat Exchange in the Environment," Publication No. 65-902, Edison Electric Institute, New York, N.Y., June 1965.

(3) State of California, Department of Public Health (Coordinated by the State Water Resources Control Board), Mercury in California, December 1973.

(4) State of California, Water Resources Control Board, Water Quality Control Plan Report (Sacramento River Basin, Sacramento-San Joaquin Delta Basin, San Joaquin Basin), 21 August 1975.

(5) U.S. Army Waterways Experiment Station, Marysville Lake Hydro-Thermal Study (Draft Report), 15 October 1976.

(6) U.S. Department of Interior, Geological Survey, Water Resources Data for California, Part II, Water Quality.

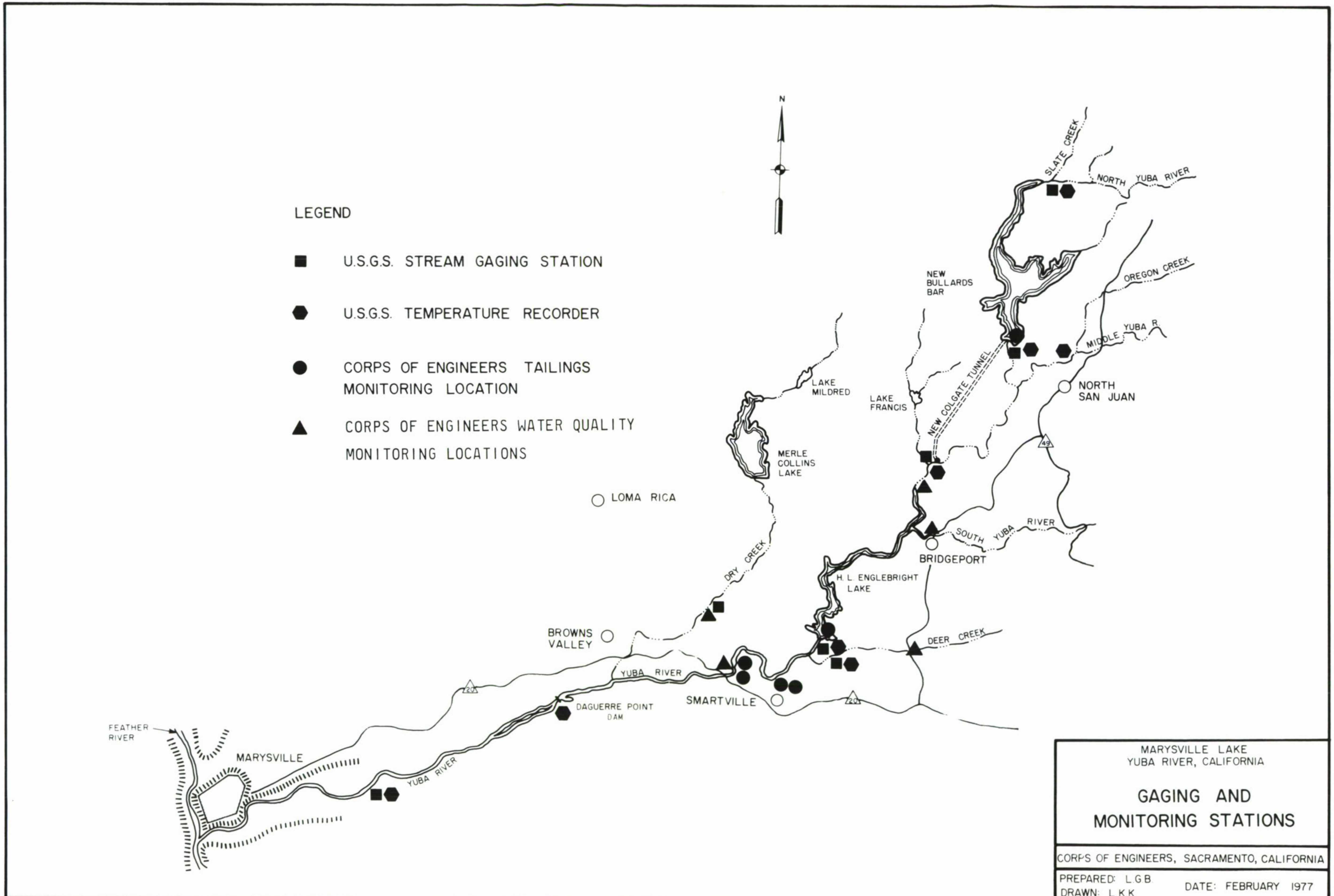
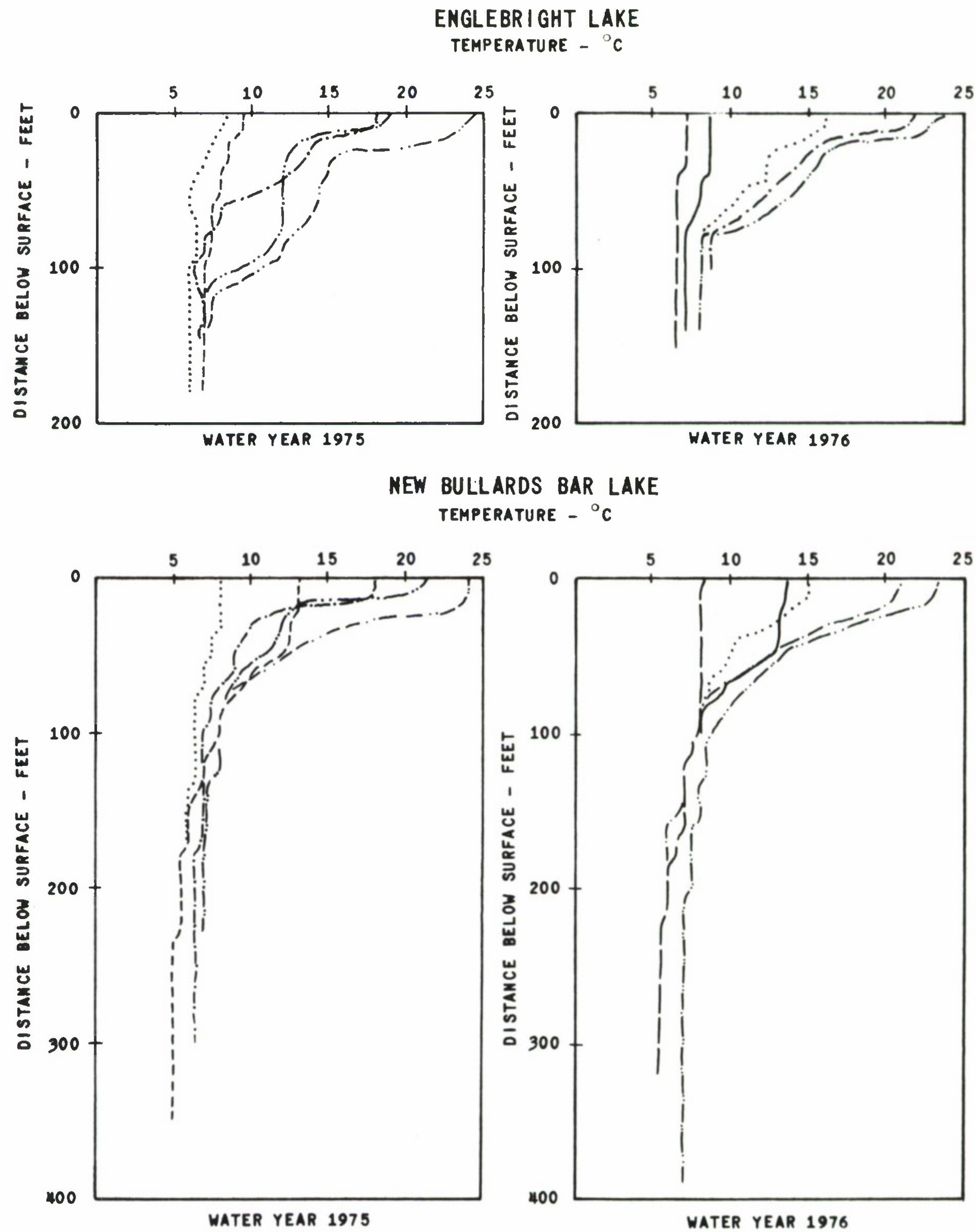

LEGEND
U.S.G.S. STREAM GAGING STATION
U.S.G.S. TEMPERATURE RECORDER
CORPS OF ENGINEERS TAILINGS MONITORING LOCATION
CORPS OF ENGINEERS WATER QUALITY MONITORING LOCATIONS
N
SLATE CREEK
NORTH YUBA RIVER
NEW BULLARDS BAR
OREGON CREEK
MIDDLE YUBA R.
NORTH SAN JUAN
LAKE MILDRED
LAKE FRANCIS
NEW COLGATE TUNNEL
MERLE COLLINS LAKE
49
LOMA RICA
SOUTH YUBA RIVER
BRIDGEPORT
DRY CREEK
H. L. ENGLEBRIGHT LAKE
BROWNS VALLEY
DEER CREEK
YUBA RIVER
20
SMARTVILLE
DAGUERRE POINT DAM
FEATHER RIVER
MARYSVILLE
YUBA RIVER
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
GAGING AND MONITORING STATIONS
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
PREPARED: L.G.B.
DRAWN: L.K.K.
DATE: FEBRUARY 1977

FIGURE G-1



LEGEND

- OCTOBER
- NOVEMBER
- DECEMBER
- APRIL
- MAY
- JUNE
- JULY

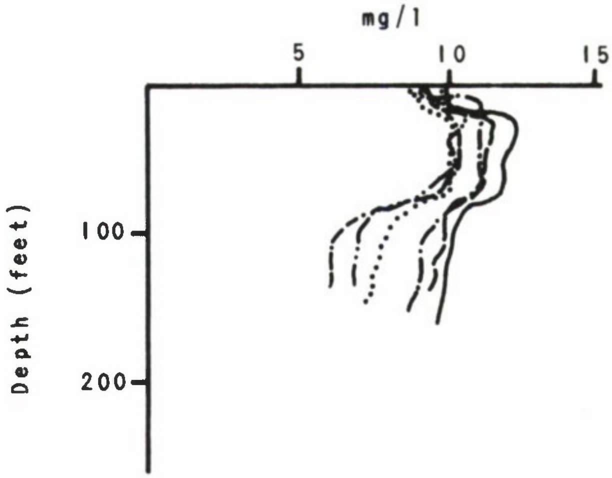
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

WATER TEMPERATURE PROFILES 1975 AND 1976

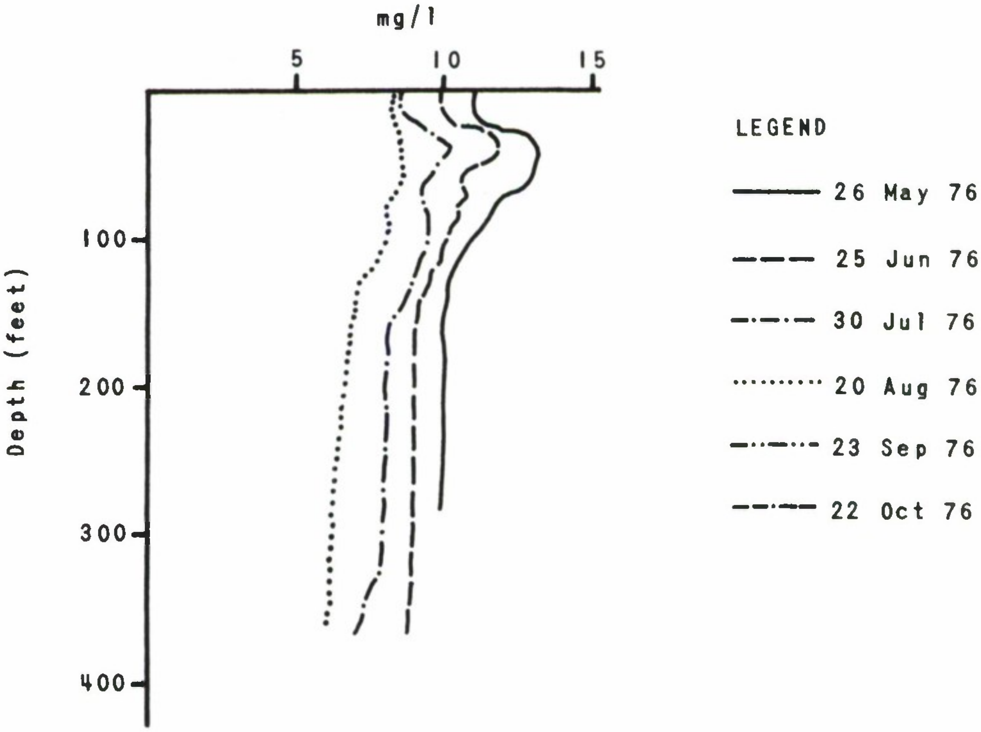
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: B.R.F.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE G-2



ENGLEBRIGHT



NEW BULLARDS BAR RESERVOIR

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

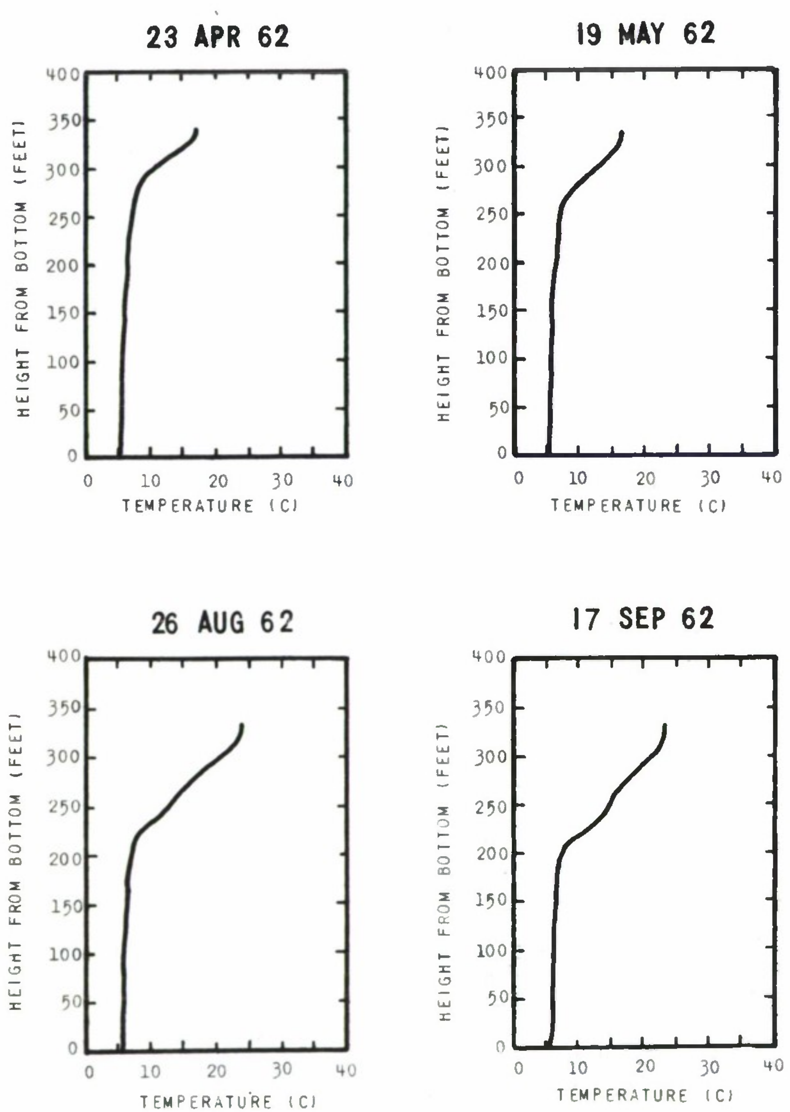
DISSOLVED OXYGEN PROFILES
1976

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: B.R.F.
Drawn: L.K.K.

Date: JAN 1977

FIGURE G-3



NOTE:

Pumpback at Withdrawal Level
1962 Hydrology (Average Year)
1962 Meteorology

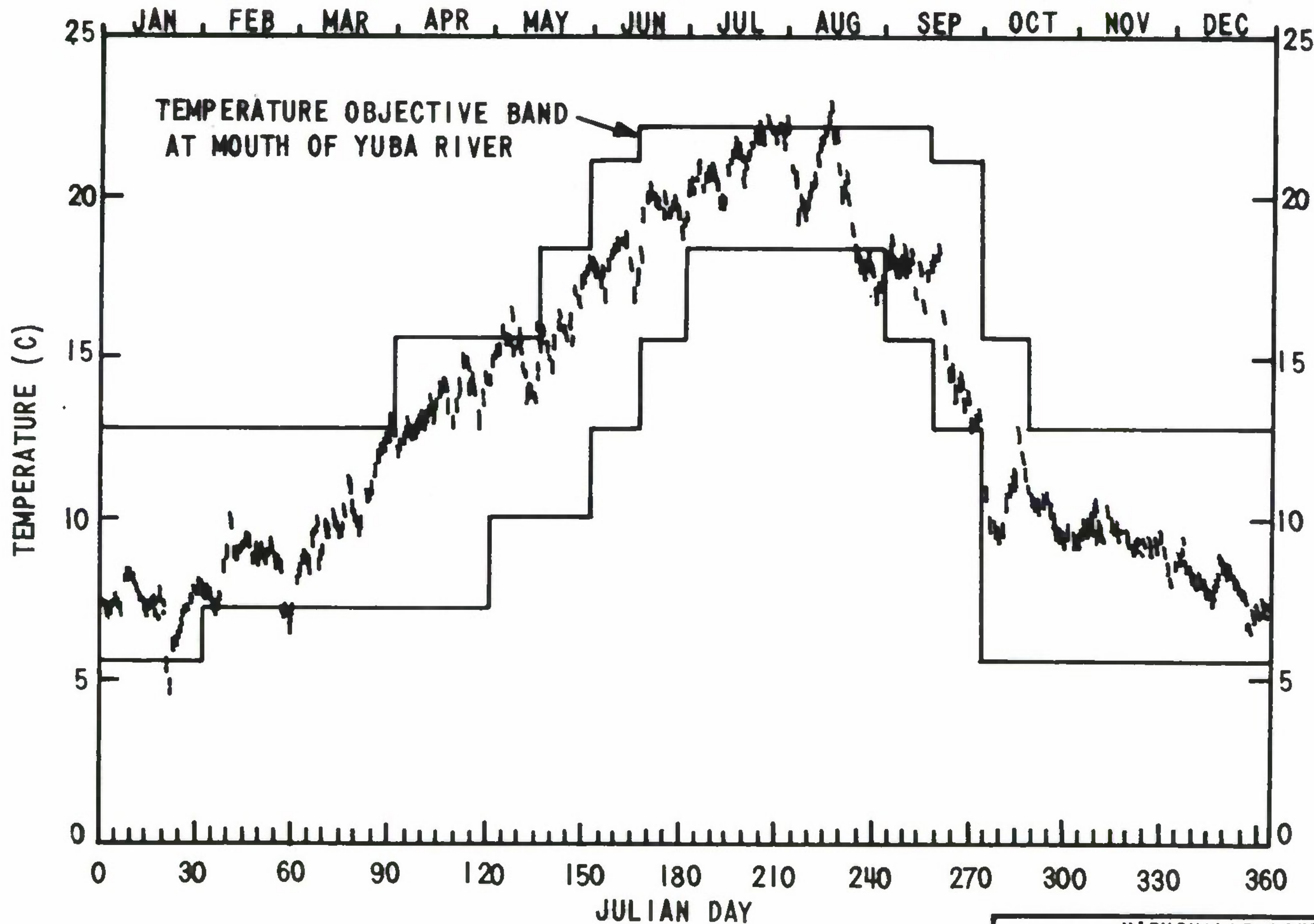
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

COMPUTED LAKE TEMPERATURE PROFILES
AVERAGE WATER YEAR
900 MW POWERPLANT

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

PREPARED: L.G.B. DATE: JANUARY 1977
DRAWN: L.K.K.

FIGURE G-4

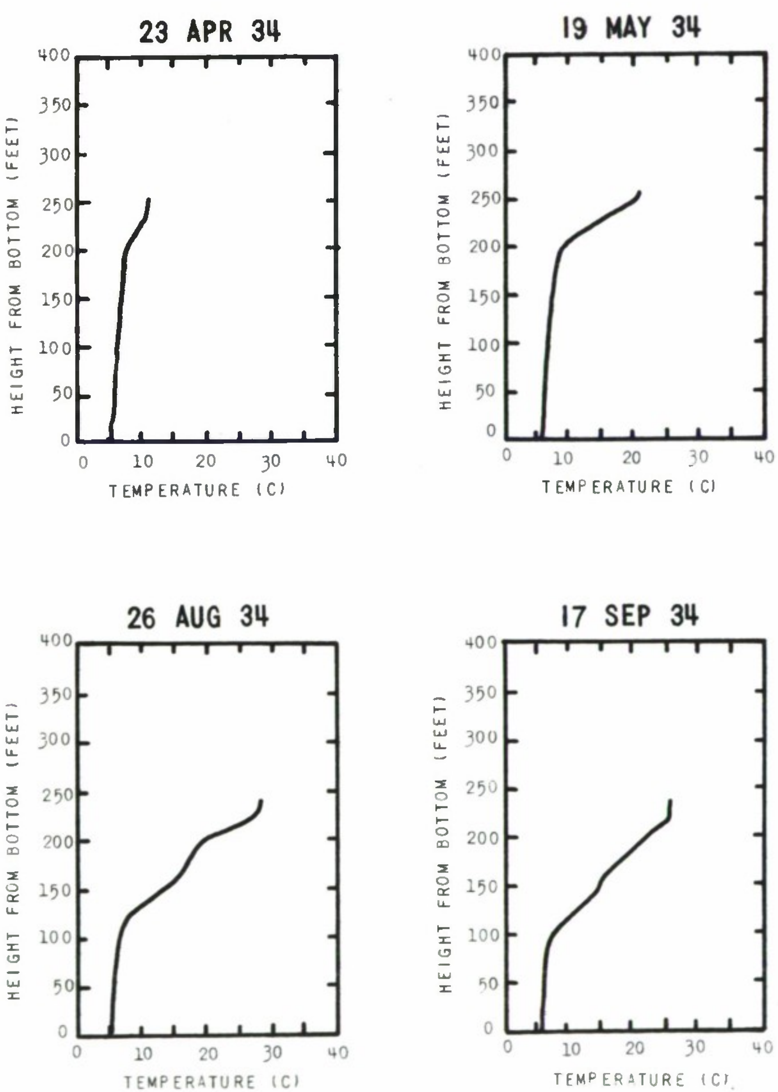


NOTE:

Pumpback at Withdrawal Level
1962 Hydrology (Average Year)
1962 Meteorology

MARYSVILLE LAKE YUBA RIVER, CALIFORNIA COMPUTED TEMPERATURES AT MOUTH OF YUBA RIVER AVERAGE WATER YEAR 900 MW POWERPLANT
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
PREPARED: L.G.B. DRAWN: L.K.K. DATE: JANUARY 1977

FIGURE G-5



NOTE:

No Pumpback
1934 Hydrology (Dry Year)
1967 Meteorology

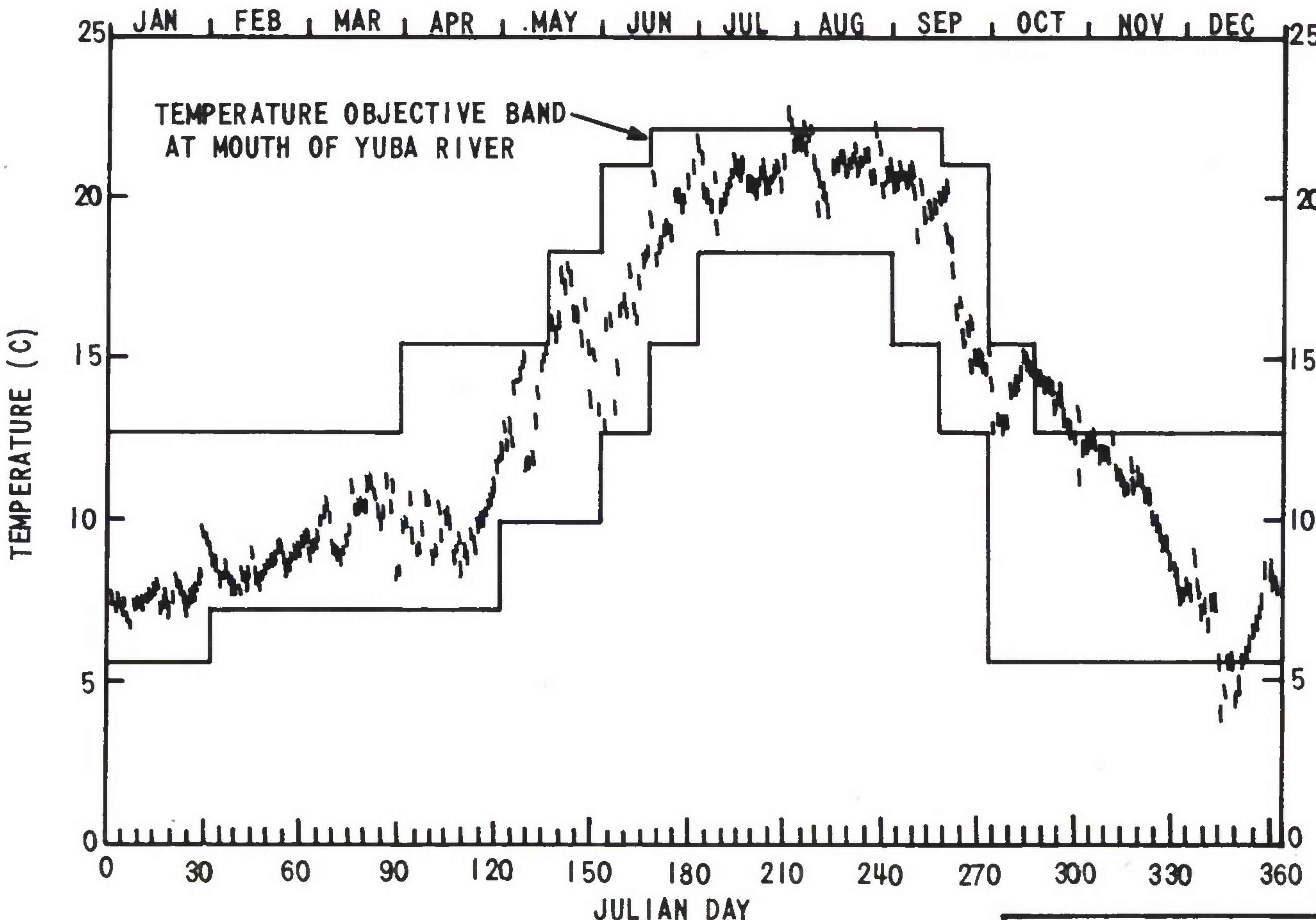
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

COMPUTED LAKE TEMPERATURE PROFILES
DRY WATER YEAR
900 MW POWERPLANT

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

PREPARED: L.G.B.
DRAWN: L.K.K.
DATE JANUARY 1977

FIGURE G-6



NOTE:

No Pumpback
1934 Hydrology (Dry Year)
1967 Meteorology

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

COMPUTED TEMPERATURES
AT MOUTH OF YUBA RIVER

DRY WATER YEAR
900 MW POWERPLANT

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

PREPARED: L.G.B.
DRAWN: L.K.K.
DATE: JANUARY 1977

FIGURE G-7

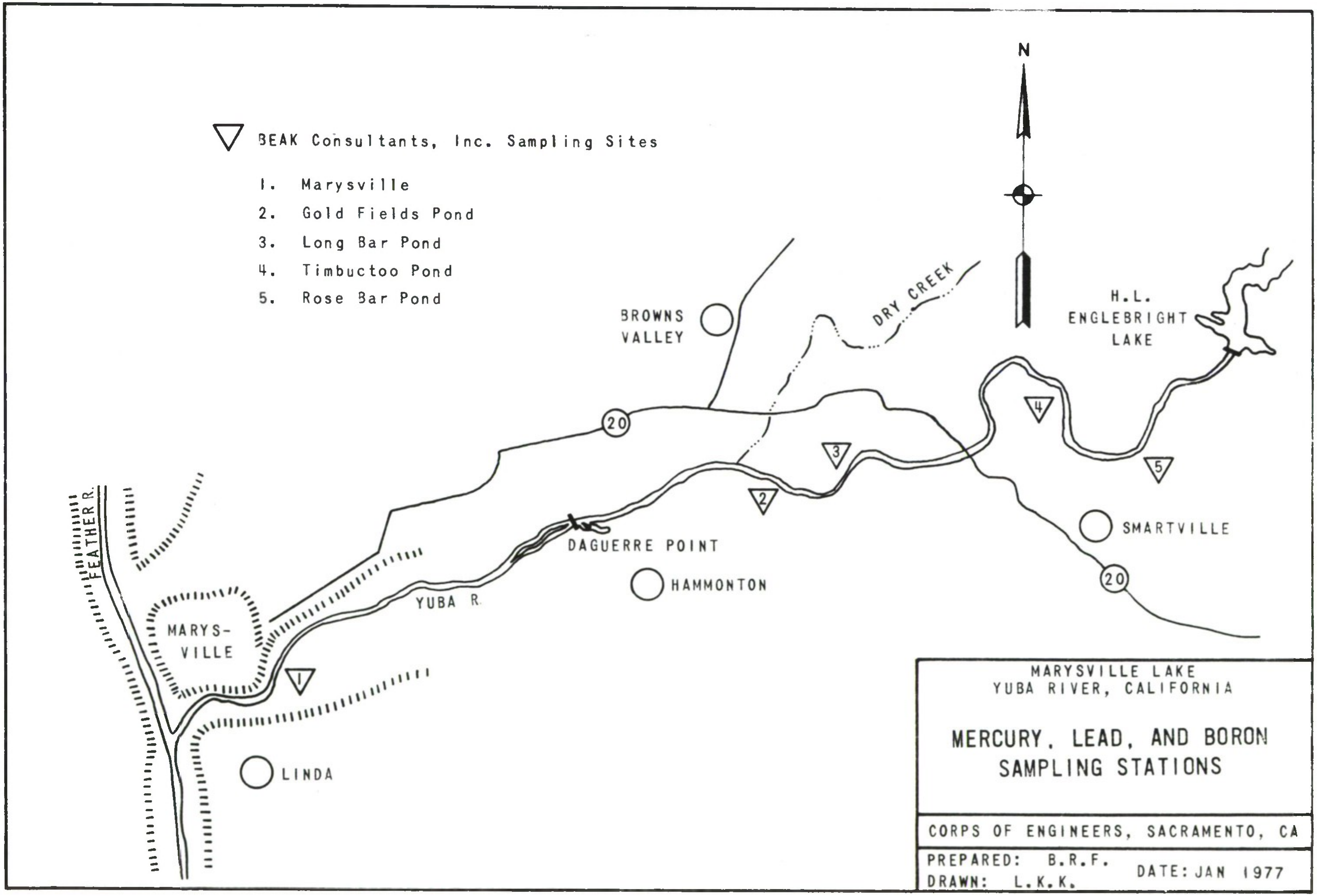

BEAK Consultants, Inc. Sampling Sites
1. Marysville
2. Gold Fields Pond
3. Long Bar Pond
4. Timbuctoo Pond
5. Rose Bar Pond
N
BROWNS VALLEY
DRY CREEK
H.L. ENGLEBRIGHT LAKE
20
DAGUERRE POINT
HAMMONTON
SMARTVILLE
YUBA R.
FEATHER R.
MARYS-VILLE
LINDA
1
2
3
4
5
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
MERCURY, LEAD, AND BORON SAMPLING STATIONS
CORPS OF ENGINEERS, SACRAMENTO, CA
PREPARED: B.R.F.
DRAWN: L.K.K.
DATE: JAN 1977

FIGURE G-8

ATTACHMENT A

Table A-1. Irrigation Water Quality Criteria[1/]

Phytotoxic Trace Elements

	For continuous use on all soils, mg/L		For use on fine textured neutral to alkaline soils over a period of 20 years, mg/L	
Aluminum	5.0		20.0	
Arsenic	0.10		2.0	
Beryllium	0.10		0.50	
Boron	0.75	For boron sensitive, semitolerant, and tolerant plants on all soils	2.0	for boron sensitive crops; can be increased for tolerant plants or for shorter periods of time.
	1.00			
	2.00			
Cadmium	0.010		0.050	
Chromium	0.10		1.0	
Cobalt	0.050		5.0	
Copper	0.20		5.0	
Fluoride	1.0		15.0	
Iron	5.0		20.0	
Lead	5.0		10.0	
Lithium	2.5[2/]		2.5	
Manganese	0.20		10.0	
Molybdenum	0.010[3/]		-	
Nickel	0.20		2.0	
Selenium	0.02		0.02	
Vanadium	0.10		1.0	
Zinc	2.0		10.0	

Pesticides

Insecticides. - No limits are given for insecticide residues in irrigation waters.

Herbicides. - Limits are only given for the following selected herbicides, due to current lack of knowledge.

Herbicide	Approx. limit, ug/L
Dalapon	200
TCA	50
2, 4-D Amine Salt	30

1/ From EPA Water Quality Criteria 1972.
2/ For citrus, the maximum concentration is 0.075 mg/L.
3/ For short-term use on soils that react with this element, a concentration of 0.050 mg/L is recommended.

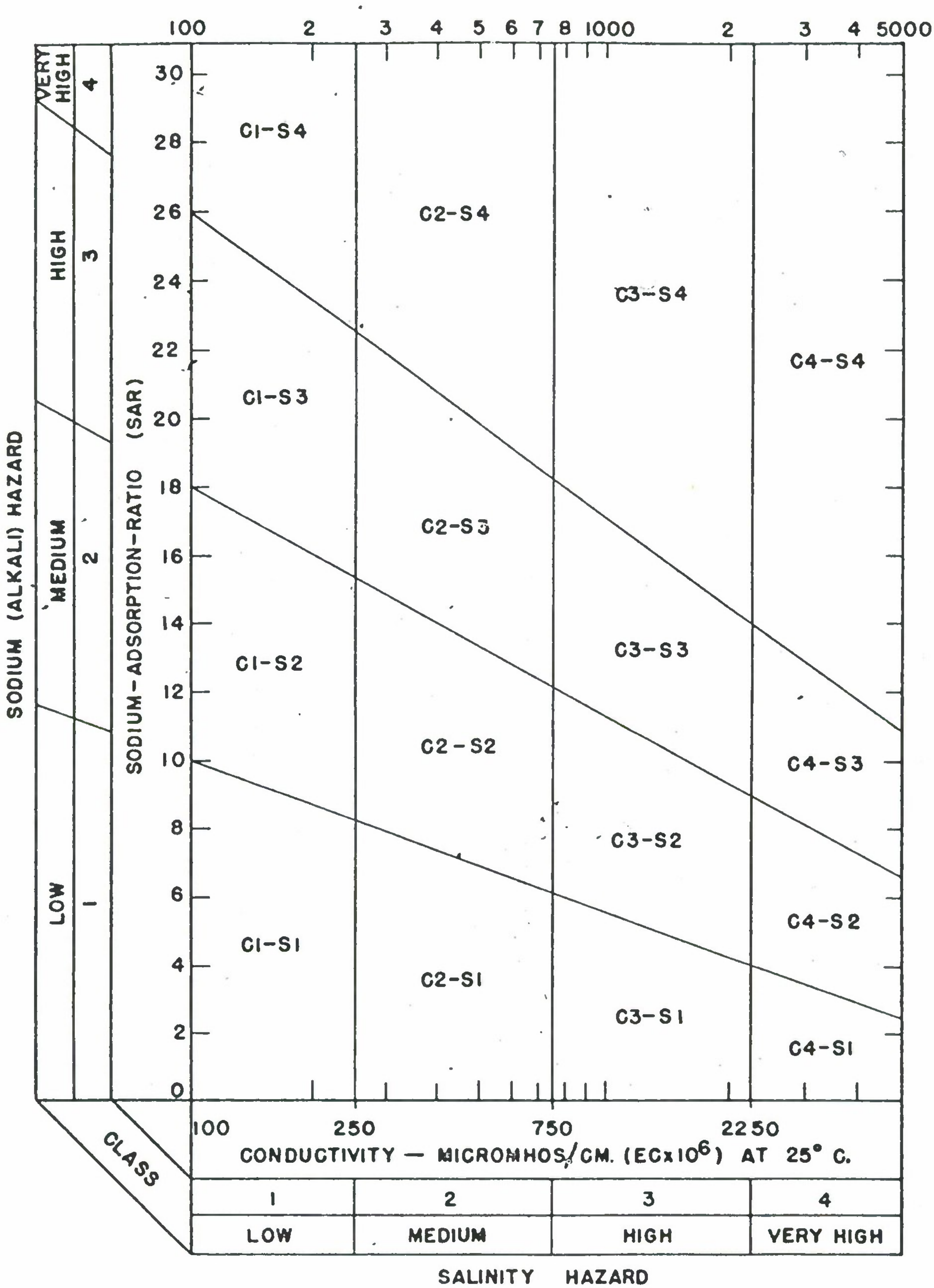


Figure A-1. Diagram for the Classification of Irrigation Waters[1/]

1/ USDA Agricultural Handbook No. 60.

Table A-1, continued

Water Salinity

Recommended Guidelines for Salinity in Irrigation Water

Classification	TDS, mg/L	EC, umho/cm
Water for which no detrimental effects are usually noticed.	500	750
Water that can have detrimental effects on sensitive crops.	500-1000	750-1500
Water that can have adverse effects on many crops; requires careful management practices.	1000-2000	1500-3000
Water that can be used for tolerant plants on permeable soils with careful management practices.	2000-5000	3000-7500

Because the sodium portion of the TDS can affect the drainage characteristics of the soil, it is often best to consider the sodium hazard along with the salinity hazard in classifying the salt suitability of a given water. Figure A-1 allows one to do this. There the sodium hazard is represented by the sodium adsorption ratio (SAR).

Soil Saturation Extract Salinity

See pps. 325-327 of EPA's Water Quality Criteria 1972, for extract salinities that cause 10, 25, and 50% yield reduction values for vegetable, field, fruit, and forage crops having high, medium, and low salt tolerances.

Table B-1 . Freshwater Aquatic Life and Wildlife Water Quality Criteria

AQUATIC LIFE

Suspended Solids.[1/] - Aquatic communities should be protected if the folfowing maximum concentrations of suspended solids exist:

High level of protection	25 mg/L
Moderate protection	80 mg/L
Low level of protection	400 mg/L
Very low level of protection over	400 mg/L

Dissolved Oxygen.[2/] - The medium dissolved oxygen concentration shall not fall below 85% of saturation in the main water mass and the 95 percentile concentration shall not fall below 75% of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

Waters designated as warmwater habitat	5.0 mg/L
Waters designated as coldwater habitat	6.0 mg/L
Waters designated as coldwater habitat and spawning	7.0 mg/L

Because the combination of water temperature and dissolved oxygen affects coldwater fishery, the table entitled "Cold Water Fishery Tolerance Zones" is included to present these effects.

pH.[2/] The pH shall not be depressed below 6.5 nor raised above 8.5. Changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated cold and warm water fishery beneficial uses.

Oil and Grease.[2/] - Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affects beneficial uses.

Polychlorinated Biphenols.[1/] Aquatic life should be protected where the maximum concentration of total PCB in unfiltered water does not exceed 0.002 ug/L at any time or place, and the residues in the general body tissues of any aquatic organism do not exceed 0.5 ug/g.

Pesticides.[1/] - Organochlorine Insecticides - The recommendations for selected organochlorine insecticides are based upon levels in water and residue concentrations in whole fish on a wet weight basis. Aquatic life should be protected where the maximum concentration of the organochlorine pesticide in the water does not exceed the values listed in the table entitled "Recommended Maximum Concentrations of Organochlorine Pesticides in Whole (Unfiltered) Water."

1/ From Water Quality Criteria 1972, EPA.
2/ From SWRQB Basin Plan for Basins 5A, B, and C, 1975.

For the protection of predators, the following values are suggested for residues in whole fish (wet weight): DDT (including DDD and DDE)-1.0 mg/kg; aldrin, dieldrin, endrin, heptachlor (including heptachlor epoxide), chlordane, lindane, benzene hexachloride, toxaphene, and endosulfan-0.1 mg/kg, either singly or in combination. For further discussion, see the section on Wildlife below.

If fish and wildlife are to be protected, and where residues exceed the recommended concentrations, pesticide use should be restricted until the recommended concentrations are reached (except where a substitute pesticide will not protect human health).

Other pesticides - The recommended maximum concentrations of other pesticides in freshwater are listed in the table entitled "Recommended Maximum Concentrations of other Pesticides in Whole (Unfiltered) Water," except that where pesticides are applied to water to kill undesirable aquatic life, the values will be higher. In the latter instances, care should be taken to avoid indiscriminate use and to insure that application of the pesticide follows the prescribed methods.

Cadmium[1/]. - Aquatic life should be protected where levels of cadmium do not exceed 0.03 mg/L in water having total hardness above 100 mg/L as $CaCO_3$, or 0.004 mg/L in waters with a hardness of 100 mg/L or below at any time or place. Habitats should be safe for crustaceans or the eggs and larvae of salmon if the levels of cadmium do not exceed 0.003 mg/L in hard water or 0.0004 mg/L in soft water at any time or place.

Chromium.[1/] - Mixed aquatic populations should be protected where the concentration of total chromium in water does not exceed 0.05 mg/L at any time or place.

Copper[3/]. - Once a 96-hour LC50 has been determined using the receiving water in question and the most sensitive important species in the locality as the test organism, a concentration of copper safe to aquatic life in that water can be estimated by multiplying the 96-hour LC50 by an application factor of 0.1.

Lead.[1/] - The concentration of lead in water should not be higher than 0.03 mg/L at any time or place in order to protect aquatic life.

Mercury[1/]. - Selected species of fish and predatory aquatic organisms should be protected when the following conditions are fulfilled: (1) the concentration of total mercury does not exceed a total body burden of 0.5 ug/g wet weight in any aquatic organism; (2) the total mercury concentrations in unfiltered water do not exceed 0.2 ug/L at any time or place; and (3) the average total mercury concentration in unfiltered water does not exceed 0.05 ug/L.

3/ The 96-hour LC50 is the concentration of toxic substance that kills 50 percent of the test organisms within the test time period of 96-hours. While 96-hour LC50's are not available for these metals for most life forms, the 48-hour LC50's for rainbow trout are shown in the figure entitled "The 48-Hour Lethal Concentrations of Three Heavy Metals for Rainbow Trout."

Zinc.[1/] - Once a 96-hour LC50 has been determined using the receiving water in question and the most sensitive important species in the locality as the test organism, a concentration of zinc safe to aquatic life in that water can be estimated by multiplying the 96-hour LC50 by an application factor of 0.005.

Cyanide.[1/] - Once a 96-hour LC50 has been determined using the receiving water in question and the most sensitive important species in the locality as the test organism, a concentration of free cyanide (CN-) safe to aquatic life in that water can be estimated by multiplying the 96-hour LC50 by an application factor of 0.05; but no concentration greater than 0.005 mg/L is recommended at any time or place.

WILDLIFE[1/]

The criteria above to protect fish will in most cases also provide the minimal requisites for wildlife. For most species of wildlife, however, considerations must also be given to the effects the water quality will have upon the food chain used by the wildlife, and on the plants which provide their shelter. The following information presents some more criteria to be considered for wildlife.

pH. - Aquatic plants of greatest value as food for waterfowl thrive best in waters with a summer pH range of 7.0 to 9.2.

Alkalinity. - Waterfowl habitats should have a bicarbonate alkalinity between 30 and 130 mg/L to be productive. Fluctuations should be less than 50 mg/L from natural conditions.

Salinity. - Salinity should be kept as close to natural conditions as possible. Rapid fluctations should be minimized.

Settleable Substances. - Settleable substances can destroy the usefulness of aquatic bottoms to waterfowl, and for that reason, settleable substances should be minimized in areas expected to support waterfowl.

Oil. - To protect waterfowl, there should be no visible floating oil.

Lead. - In order to reduce the incidence of lead poisoning in freshwater and marine waterfowl, it is recommended that: non-toxic shot be used, or that no further lead shot be introduced into zones of shot deposition if lead shot concentrations exceed 1.0 shot per 4 square feet in the top two inches of sediment.

Botulism Poisoning. - Outbreaks of botulism poisoning tend to be associated with, or affected by insect die-offs, water temperature above 70F, fluctuating water levels, and elevated concentrations of dissolved solids. Management of these factors may reduce outbreaks of botulism poisoning.

Pesticides. - In order to protect most species of aquatic wildlife, the total DDT concentration on a wet-weight basis should be less than 1 mg/kg in any aquatic plants or animals. (Also see Recommendations for Pesticides under the Aquatic Life section above).

Polychlorinated Biphenols. - Because of the persistence of PCB and their susceptibility to biological magnification, it is recommended that the body burdens of PCB in birds and mammals not be permitted to increase and that monitoring programs be instituted.

Mercury. - Fish-eating birds should be protected if mercury levels in fish do not exceed 0.5 ug/g.

Since the recommendation of 0.5 ug/g mercury in fish provides little or no safety margin for fisheating wildlife, it is recommended that the safety of the 0.5 ug/g level be reevaluated as soon as possible.

Table B-2. Recommended Maximum Concentrations of Organochlorine Pesticides in Whole (Unfiltered) Water, Sampled at any Time and any Place.

Organochlorine pesticides	Recommended maximum concentration (µg/l)
Aldrin	0.01
DDT	0.002
TDE	0.006
Dieldrin	0.005
Chlordane	0.04
Endosulfan	0.003
Endrin	0.002
Heptachlor	0.01
Lindane	0.02
Methoxychlor	0.005
Toxaphene	0.01

[a] Concentrations were determined by multiplying the acute toxicity values for the more sensitive species (Appendix II-D) by an application factor of 0.01 except where an experimentally derived application factor is indicated.

Table B-3. Recommended Maximum Concentrations of other Pesticides in Whole (Unfiltered) Water, Sampled at any Time and any Place.

Organophosphate insecticides	Recommended maximum concentration (µg/l)
Abate	(b)
Azinphosmethyl	0.001
Azinphosethyl	(b)
Carbophenothion	(b)
Chlorothion	(b)
Ciodrin	0.1
Coumaphos	0.001
Demeton	(b)
Diazinon	0.009
Dichlorvos	0.001
Dioxathion	0.09
Disulfoton	0.05
Dursban	0.001
Ethion	0.02
EPN	0.06
Fenthion	0.006
Malathion	0.008
Methyl Parathion	(b)
Mevinphos	0.002
Naled	0.004
Oxydemeton methyl	0.4
Parathion	0.0004
Phorate	(b)
Phosphamidon	0.03
Ronnel	(b)
TEPP	0.4
Trichlorophon	0.002

Table B-3, continued.

Carbamate insecticides	Recommended maximum concentrations (µg/l)
Aminocarb	(b)
Bayer	(b)
Baygon	(b)
Carbaryl	0.02
Zectran	0.1

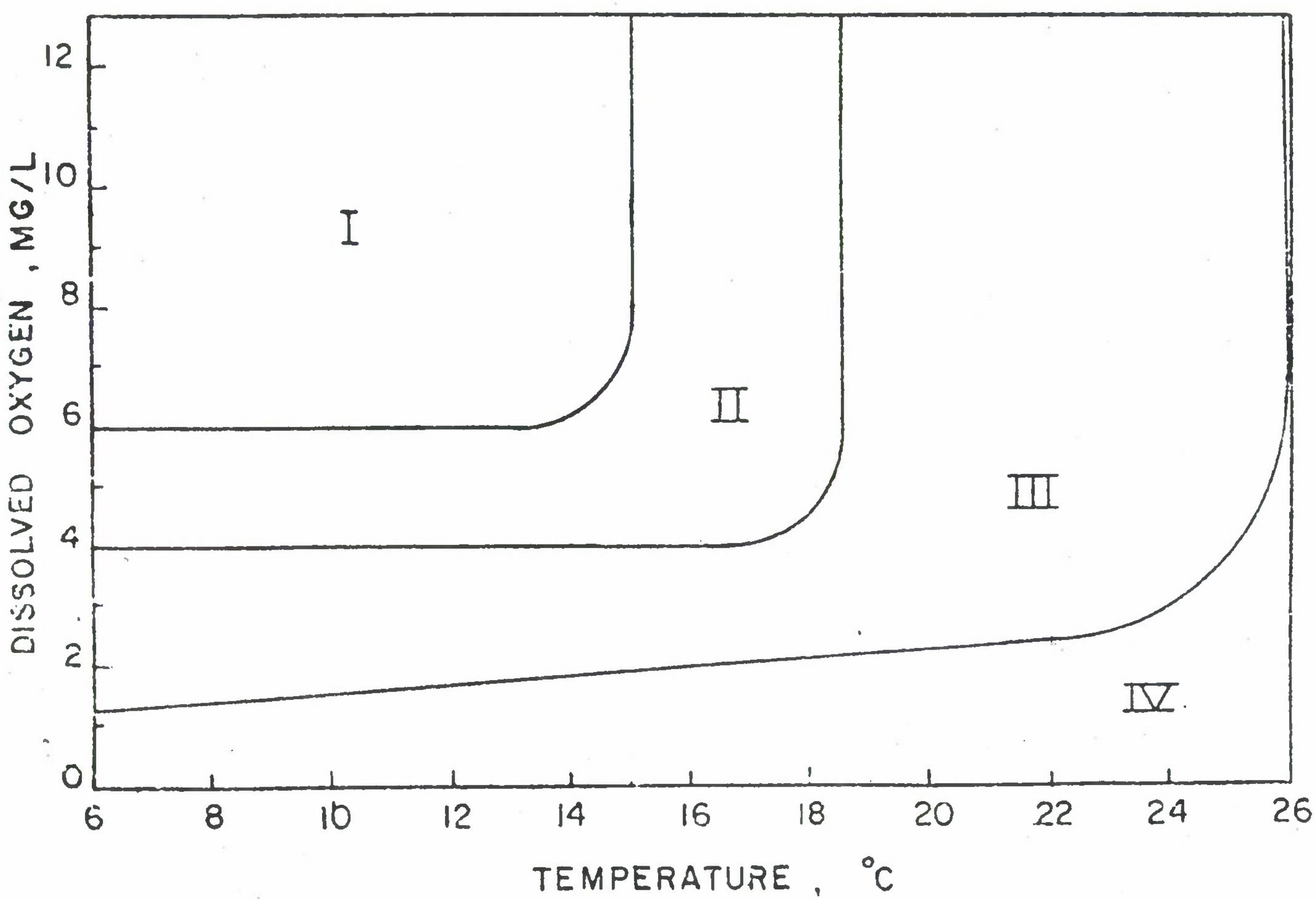
Herbicides, fungicides and defoliants	Recommended maximum concentrations (µg/l)
Acrolein	(b)
Aminotriazole	300.0
Balan	(b)
Bensulide	(b)
Choroxuron	(b)
CIPC	(b)
Dacthal	(b)
Dalapon	110.0
DEF	(b)
Dexon	(b)
Dicamba	200
Dichlobenil	37.0
Dichlone	0.2
Diquat	0.5
Diuron	1.6
Difolitan	(b)
Dinitrobutyl phenol	(b)
Diphenamid	(b)
2,4-D (PGBE)	(b)
2,4-D (BEE)	4.0
2,4-D (IOE)	(b)
2,4-D (Diethylamine salts)	(b)
Endothal (Disodium salt)	(b)
Endothal (Dipotassium salt)	(b)
Eptam	(b)
Fenac (Sodium salt)	45.0
Hyamine-1622	(b)
Hyamine-2389	(b)
Hydrothal-47	(b)
Hydrothal-191	(b)
Hydrothal plus	(b)
IPC	(b)
MCPA	(b)
Molinate	(b)
Monuron	(b)
Paraquat	(b)
Pebulate	(b)
Picloram	(b)
Propanil	(b)
Silvex (BEE)	2.5
Silvex (PGBE)	2.0
Silvex (IOE)	(b)
Silvex (Potassium salt)	(b)
Simazine	10.0
Trifluralin	(b)
Vernolate	(b)

Botanicals	Recommended maximum concentrations (µg/l)
Allethrin	0.002
Pyrethrum	0.01
Rotenone	10.0

[a] Concentrations were determined by multiplying the acute toxicity values for the more sensitive species (Appendix II-D) by an application factor of 0.01 except where an experimentally derived application factor is indicated.

[b] Insufficient data to determine safe concentrations.

Figure B-1. Cold Water Fishery Tolerance Zones



Zone I. Acceptable levels for normal growth and development of cold water fish.

Zone II. Combination of dissolved oxygen and temperature under which cold water fish would live for extended periods; however, growth and reproduction less than in Zone I.

Zone III. Combination of dissolved oxygen and temperature where cold water fish would lead a marginal existence.

Zone IV. Combination of dissolved oxygen and temperature that is fatal to cold water fish.

This curve from Journal, Water Pollution Control Federation, January 1973, "Dissolved Oxygen and Temperature in a Stratified Lake", by Smith and Bella.

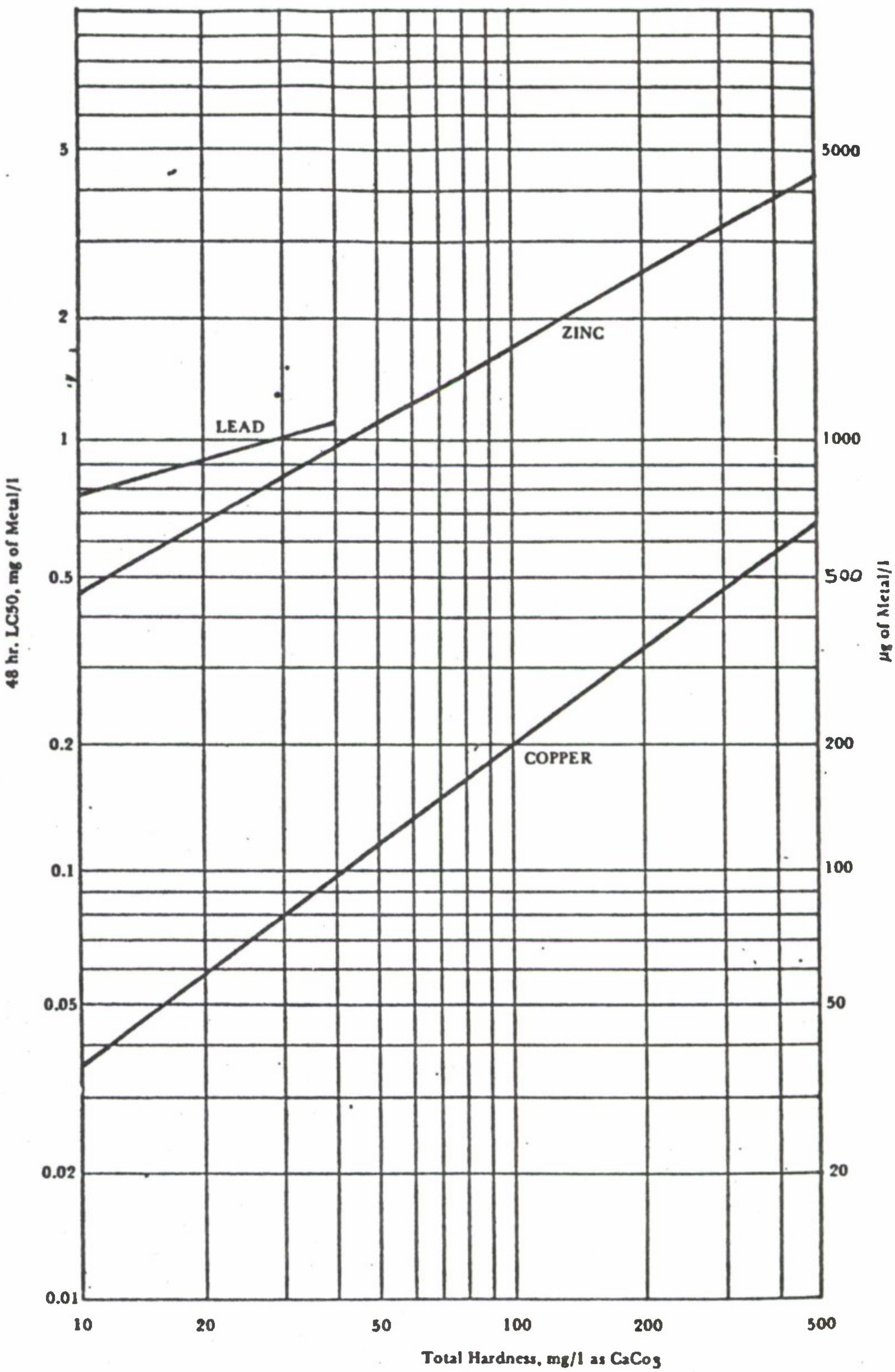


FIGURE B-2 —The 48-Hour Lethal Concentrations of Three Heavy Metals for Rainbow Trout (Salmo gairdneri) 1/

1/ From Water Quality Criteria 1972, U. S. Environmental Protection Agency.

Table C-1. Guidelines for Water-Contact Recreation Criteria[1/]

(Natural fresh water or salt water)

Constituent or Characteristic	Threshold(a) Concentration	Limiting(b) Concentration
Geometric mean fecal coliform density, by MF count or MPN, per 100 ml	200(c)	(e)
Visible solids of sewage origin	none	none
Methylene blue active substances	1(d)	2
Suspended solids, mg/l	20(d)	100
Floatable oil & grease, mg/l	none	5
Emulsified oil & grease, mg/l	10(d)	20
Turbidity, Secchi disc depth, ft	>4	-
Color, standard cobalt scale, units	15(d)	100
Threshold odor number	32(d)	256
Range of pH	6.5-8.3	6.0-9.0
Temperature, maximum, °C	30	-

(a) Concentrations lower than these threshold values should not interfere with the use of such waters for swimming, bathing, or other water contact. Beyond these threshold values, complaints may be received from the public, or health authorities may become concerned.

(b) Limiting concentrations are those that prohibit or seriously impair the value of such waters for swimming, bathing, or other water contact.

(c) The log mean concentration of fecal coliforms over a 30-day period should not exceed 200/100 ml, nor should more than 10 percent of the samples over a 30-day period exceed 400/100 ml.

(d) Values not to be exceeded in more than 20 percent of any 20 consecutive samples nor in any three consecutive samples. The frequency of sampling should be specified.

(e) On the basis of epidemiological evidence, no limiting concentration can be specified provided that no gross fecal pollution is evident.

1/ From Comprehensive Water Quality Control Plan for Basins 5A, 5B, and 5C, report for State Water Resources Control Board by Bay Valley Consultants, May 1973.

Other temperature considerations.[2/]

Water ranging in temperature from 78-86°F (26-30°C) is comfortable to most summers throughout prolonged periods of moderate physical exertion. The following chart shows the upper and lower safe water temperatures for various periods of immersion.

Duration Hours	32 / 0	41 / 5	50 / 10	59 / 15	68 / 20	78 / 25	86 / 30	95 / 35	104°F / 40°C
	Temperature of the Water								
0.5	M	M	S	S	S	S	S	S	M
1.0	L	M	M	S	S	S	S	S	L
2.0	L	L	M	M	S	S	S	S	L
3.0	L	L	L	M	S	S	S	S	L
4.0	L	L	L	L	M	S	S	S	L

L = Lethal, 100% expectancy of death.
M = Marginal, 50% expectancy of unconsiousness, probably drowning.
S = Safe, 100% survival.

2/ From Water Quality Criteria 1972, EPA.

ATTACHMENT D
TABLE D-1
STATE OF CALIFORNIA
OBJECTIVES FOR INLAND SURFACE WATERS
SACRAMENTO RIVER BASIN

This table includes water quality objectives that apply to all inland surface waters (excluding the Delta) of the basins, and objectives that apply only to specific surface water bodies.[1/] As part of the state's continuous planning process, data will be collected and more specific water quality objectives will be developed for those mineral and nutrient constituents where sufficient information is presently not available for the establishment of specific objectives.

Bacteria

In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 ml.

Biostimulatory Substances

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

In most water bodies, water quality objectives for nitrogen will not be established until studies to determine the specific effects of nitrogen on algal growth in the Delta, the lower San Joaquin River, and San Francisco Bay are completed.

At the present time, only limited productive areas within the Delta (e.g., Sherman Island and Franks Tract) show any significant levels of sensitivity to nitrogen. Elsewhere in the Delta, indications are that algal levels would not be influenced by limiting nitrogen because light penetration (a function of turbidity) may be the limiting factor. Until the relationships between nutrients from controllable and uncontrollable sources and algal levels have been established, it is not productive to set specific numerical water quality objectives for nitrogen in the basin waters. Wherever possible, facility plans should maintain flexibility to allow for future nitrogen removal processes.

Chemical Constituents

Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. Water designated for use as domestic or municipal supply (MUNI) shall not contain concentrations of chemical constituents in excess of the limits specified in California Administrative

1/ For brevity, those specific objectives which do not pertain to the Yuba-Feather River System are deleted in this report.

Code, Title 17, Chapter 5, Subchapter 1, Group 1, Article 4, Section 7019, Tables 2, 3, and 4. The limits described therein will be reviewed on a case-by-case basis in order to assure protection of beneficial uses other than MUN, as appropriate. To the extent of any conflict with the above, the more stringent objective applies.

The following objectives for electrical conductivity and total dissolved solids apply to the water bodies specified. To the extent of any conflict with the above, the more stringent shall apply.

(1) The 25°C Electrical Conductivity:	Applicable Water Body
Shall not exceed 150 micromhos/cm (90 percentile) in well-mixed waters of the Feather River.	North Fork, Feather River (33) Middle Fork, Feather River, Little Last Chance Creek to Lake Oroville (36) Feather River, Fish Barrier Dam to Sacramento River (40)

Color

Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses.

Dissolved Oxygen

The monthly median of the mean daily dissolved oxygen concentration shall not fall below 85 percent of saturation in the main water mass and the 95 percentile concentration shall not fall below 75 percent of saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

Waters designated WARM	5.0 mg/L
Waters designated COLD	7.0 mg/L
Waters designated SPWN	7.0 mg/L

The following objectives apply to the water bodies specified. To the extent of any conflict with the above, the more stringent objective applies. The dissolved oxygen concentrations:

	Applicable Water Body
(1) Shall be greater than or equal to 8.0 mg/L from Oroville Fish Barrier Dam to Honcut Creek from 1 September to 31 May.	Feather River, Fish Barrier Dam to Sacramento River (40).

Floating Material

Water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses.

Oil and Grease

Waters shall not contain oils, greases, waxes, or other materials in concentrations that cause nuisance, result in a visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses.

pH

The pH shall not be depressed below 6.5 nor raised above 8.5 Changes in normal ambient pH levels shall not exceed 0.5 in fresh waters with designated COLD or WARM beneficial uses.

Pesticides

No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life that adversely affects beneficial uses. Pesticides are defined as any substance or mixture of substances used to control objectionable insects, weeds, rodents, fungi, or other forms of plant or animal life.

Total identifiable chlorinated hydrocarbon pesticides shall not be present at concentrations detectable within the accuracy of analytical methods prescribed in Standard Methods for the Examination of Water and Wastewater, latest edition, or other equivalent methods approved by the Executive Officer.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the limiting concentrations set forth in California Administrative Code, Title 17, Chapter 5, Subchapter 1, Group 1, Article 4, Section 7019, Table 4.

Radioactivity

Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal or aquatic life nor that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal or aquatic life.

Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the limits specified in California Administrative Code, Title 17, Chapter 5, Subchapter 1, Group 1, Article 4, Section 7019, Table 5.

Sediment

The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

Settleable Material

Waters shall not contain substances in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

Suspended Material

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

Tastes and Odors

Waters shall not contain taste- or odor-producing substances in concentrations that impart undesireable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin - that cause nuisance, or otherwise adversely affect beneficial uses.

Temperature

The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.

At no time or place shall the temperature of any COLD intrastate water be increased more than 5°F above natural receiving water temperature.

At no time or place shall the temperature of WARM intrastate waters be increased more than 5°F above natural receiving water temperature.

Toxicity

All waters shall be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration or other appropriate methods as specified by the Regional Board.

The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge, or, when necessary, for other control water that is consistent with the requirements for "experimental water" as described in Standard Methods for the Examination of Water and Wastewater, latest edition. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon acute bioassays of effluents will be prescribed where appropriate: additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available; and source control of toxic substances will be encouraged.

Turbidity

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.

Turbidity (Continued)

Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

> Where natural turbidity is between 0 and 50 Jackson Turbidity Units (JTU), increases shall not exceed 20 percent.
>
> Where natural turbidity is between 50 and 100 JTU, increases shall not exceed 10 JTU.
>
> Where natural turbidity is greater than 100 JTU, increases shall not exceed 10 percent.

Exceptions to the above limits will be considered when a dredging operation can cause an increase in turbidity. In this case, an allowable zone of dilution within which turbidity in excess of limits can be tolerated will be defined for the operation and prescribed in a discharge permit.

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX H - GEOLOGY, SEISMICITY, AND SOILS

APPENDIX H
GEOLOGY, SEISMICITY, AND SOILS

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APPENDIX H

GEOLOGY, SEISMICITY, AND SOILS

1. Regional geology and structure. -

The project area is in the northern part of the Western Sierra Nevada Metamorphic Belt. The entire belt, approximately 20-40 miles wide and 180 miles long, consists of a series of northwest trending assemblages of metamorphosed Paleozoic and Mesozoic volcanic and sedimentary rocks which have been intruded by Mesozoic igneous bodies. This basement complex is locally unconformably overlain by erosional remnants of a formerly extensive capping of Tertiary volcanic rocks and Tertiary through Quaternary sedimentary deposits.

The foothills area is structurally complex and has been subjected to varying degrees of folding, shearing, and faulting - all of which apparently occurred at the close of the Jurassic Period.(6)(7) The dominant structural feature of the area is a wide regional shear zone which may be a northern extension of the Bear Mountain fault zone. The relationship between the shear zone and the Bear Mountain fault zone is not well understood, but the two features appear to be different in nature. On the Geologic Map of California (3)(15) the two zones are separated by the Rocklin Pluton which is a large body of intrusive igneous rock. The faults of the Western

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

Metamorphic Belt have been variously interpreted, within the concept of global plate tectonics, as representing sutures or plate boundaries formed during plate convergence and subduction during Jurassic time, or that the regional shear zone represents a melange separating relatively undeformed volcanics to the west from pillow basalt, dike complex, and intrusive rock of the Smartville ophiolite sequence to the east.(16) Duffield and Sharp, 1975, have reinterpreted similar rocks to the south, in Amador County, as being part of a melange with a limited degree of internal order, and that they represent a subduction zone in which subhorizontal faulting occurred at a continental margin before the strata were tilted to their present steeply dipping position during the Nevadan orogeny.(10) The melange may well mark the locus of convergence between an oceanic plate that abuts and plunges beneath a continental margin.

2. <u>Areal geology and structure</u>. -

The project area is underlain by bedrock consisting of predominantly late Jurassic metavolcanic and metasedimentary rocks. These units were originally mapped by Lindgren and Turner, 1895, (14) as porphyrite, amphibolite, and diabase.(7) Prior to the work of Clark, 1954, (4) they were mapped on U.S. Geological Survey (USGS) folios as part of the Paleozoic "Western Belt of the Calaveras Formation." (10) The name Calaveras is no longer used, they may be correlative with the Oregon City and Monte de Oro Formations (9) to the north and the Gopher Ridge-Copper Hill Volcanics and the Mariposa Formation (10)(7) to the south. The metavolcanic rocks vary from basic to

intermediate (basaltic to andesitic) in composition and have a wide variety of textures. They consist predominantly of subaqueous extrusions - flows, massive to pillow structured, amygdaloidal and porphyritic, pyroclastic breccias and agglomerates, crystal tuffs and tuff breccias. Some of the metavolcanics are intercalated with relatively thin layers or lenses of metavolcanic sediments. The metavolcanic sediments (or metasediments) generally are aphanitic or very fine grained, siliceous, sometimes laminated, tuffaceous to pelitic, and are usually lighter colored than the metavolcanics. Scattered to abundant cross-cutting or concordant dikes occur within the metavolcanics. They range from diabasic to felsic, and many are feeders for the various flows and are essentially the same composition as the flows. The intrusive igneous bodies to the east and north of the project area vary in composition from gabbroic, dioritic, to granitic.(8)

Attitudes of most structural features, such as bedding, foliation (metamorphic rock cleavage), shears, and faults, generally parallels the N 15° to 45° W dominant structural grain of the foothills. From west to east, along Highway 20, bedding dips moderately to steeply eastward from Browns Valley Ridge to the regional shear zone, is nearly vertical through the shear zone, then, where recognizable, it dips moderately to steeply westward to Timbuctoo Bend on the Yuba River.

3. Regional tectonics. -

Historically, active faults with large earthquake motions significant to the project area have been related to the San Andreas fault system to the west, the Sierra Nevada Frontal fault system to the east, or one of the many faults in the Basin and Range Province of Nevada.(18) Prior to the Richter magnitude 5.7 Oroville earthquake, on 1 August 1975, there was no evidence to suggest that the regional shear zone or any of the faults in the Foothills fault system was active or was a source of significant earthquakes or surface faulting.(16) The major structure of the Western Sierra Nevada Metamorphic Belt is the Foothills fault system, (5)(6) which consists of two main components, the Melones fault zone to the east and the Bear Mountain fault zone to the west. The regional shear zone in the project area is on the same northwest trend as the portion of the Bear Mountain fault zone south of the Cosumnes River.

4. Seismicity. -

The epicenter for the Richter magnitude 5.7 Oroville earthquake, on 1 August 1975, was located about 5-1/2 miles south of Oroville, about 25 miles from Parks Bar. Its location is at the center of the line between Sections 4 and 9, T. 18 N., R. 4 E., on the USGS Palermo, California 7-1/2 Minute Quadrangle map, 1970. Ground cracks were found at several localities following the earthquake and subsequent aftershocks. Some of them were interpreted as having developed due to differential settlement or shaking.

Others, such as the Cleveland Hill crack zone, are a result of displacement along a preexisting bedrock fault referred to as the Cleveland Hill fault. This crack zone is about 4 miles due east of the epicenter and consists of a pattern of well developed en echelon, left-stepping fractures about 1 mile long. Offsets on the cracks indicate an oblique slip fault with normal and right lateral slip components of displacement, presumably resulting from east-west crustal extension. There was a maximum of 1-1/2 to 2 inches of vertical and 1 to 1-1/2 inches of right lateral displacement.(11) Two other crack zones referred together as the Mission Olive crack zones, were discovered just north of the Cleveland Hill crack zone. They are roughly parallel, about 400 meters apart, and trend about due north, for nearly 2 miles. They are similar to the Cleveland Hill cracks but are not as continuous.(1) Aftershock hypocenters and focal depths indicate normal faulting, downdropped on the west side, along a north-south fault dipping about 60° to 62° westward.(13) According to Akers and McQuilkin (1975) (1) the Cleveland Hill fault is probably the fault or one of the faults in a complex north trending zone of faults directly related to the Oroville earthquake sequence. The Cleveland Hill fault appears to project into, and may be structurally related to the Swain Ravine lineament which continues southeastward through the Dry Creek damsite (about 13-1/2 miles). It crosses the Yuba River about 2,500 feet west of the Parks Bar damsite.

Until 1975, historical earthquakes in the surrounding area have not been accurately located because there was a lack of identified Quaternary faults, there was no clear association of earthquakes with mapped faults, and no

surface ruptures were observed.(16) The closest significant historical earthquake was the Richter magnitude 5.7 earthquake on 8 February 1940, which originated about 50 miles north-northwest of the project area. The most significant earthquake from more distant sources was the Richter magnitude 8.3 San Francisco earthquake of 18 April 1906 on the San Andreas fault system. Its epicenter was approximately 115 miles southwest from the project area. The closest moderate-size earthquake occurred in the northern part of the Sierra Nevada Frontal fault system, which is located east of the Foothills fault system and defines the eastern boundary of the Sierra Nevada structural block. That was the Richter magnitude 6.3 Truckee earthquake on 12 September 1966. It reportedly was on the Russel Valley fault located about 65 miles east-northeast of the project area.(18)

The Oroville earthquake made it necessary to consider a local earthquake, as well as strong distant sources, in estimating the magnitude and recurrence interval for earthquakes that could affect the project. From the historical record, distant sources of earthquakes are mainly from events on the San Andreas fault system, on the west side of the Great Valley, and from the Sierra Nevada Frontal fault system. The distances to these earthquake sources would significantly attenuate seismic waves reaching the project site. The sparse historic record shows that only two moderate earthquakes have occurred within the northern region of the Foothills fault system during the last 150 years.

Methods for estimating probability of earthquake recurrence and likely ground motion intensities that could occur within the project area use the record of historical earthquakes and mathematical means relating to the linear extent of faulting and amount of displacement. Because of the relatively small number of earthquakes that have occurred within the northern area of the Foothills fault system, estimates of recurrence intervals or magnitude for earthquakes associated with particular structural features must be regarded as having lower reliability than estimates for the entire region. Based on the historical record, it appears that, even though the activity was mainly to the north of the sites, an earthquake with a magnitude on the order of 5.7 is possible within the area. Relating earthquake magnitude to fault length and displacement by using mathematical formulas and curves has many weaknesses or uncertainties because of mixing data from different kinds of faults, uncertainties about fault displacement through different kinds of geologic materials, and insufficient subsurface data on faulting. By applying the formulas and curves, a range of magnitudes on the order of 5.0 to 6.5 is possible.

In a report prepared for the Corps of Engineers by Bruce A. Bolt (1976) (2) and reviewed by H. Bolton Seed, it was concluded that the most severe earthquake motions likely to develop at the project area will be those due to either a local earthquake in the Foothills fault zone having a magnitude of about 6.25 and centered about 15 kms. (9 miles) from the main Yuba River damsite or an earthquake of magnitude 7.5 located on one of the faults on the west side of the

Great Valley at a minimum distance of about 80 kms. (50 miles) from the project site. They postulated a design earthquake with a magnitude of 6.25, the same as that used by Woodward-Clyde Consultants (October 1976) (17) to evaluate the seismic stability of the afterbay dam.

5. Geological investigations by other agencies. -

Prior to the 1 August 1975 Oroville earthquake, the Pacific Gas and Electric Company (PG&E) was conducting a seismic investigation of the Foothills fault system (contracted by an A-E firm) for location planning of nuclear powerplants. The same A-E firm also prepared a report (17) for the U.S. Army Corps of Engineers on the seismic stability of the Marysville Lake project at the Browns Valley site. After the Oroville earthquake they prepared a report (16) for the Corps of Engineers on the potential for earthquakes and surface faulting at the afterbay for the project at the Parks Bar site. They are engaged in a more extensive study of the Foothills fault system for PG&E and also for the U.S. Bureau of Reclamation related to the Auburn Dam project.

Immediately after the Oroville earthquake, the California Department of Water Resources investigated the surrounding epicentral area and the Oroville Dam area for evidence of ground cracking and surface faulting. Three known faults west of the dam were also inspected, but no evidence of recent movement was found.(1) Other contributions consisted of seismological investigations by the USGS and the initiation of additional geological mapping by the California Division of Mines and Geology. The consultants and the California

Department of Water Resources investigated many reported isolated cracks and zones of ground cracks. The most significant of these zones were named the "Palermo," the "Mission Olive," and the "Cleveland Hill" crack zones. From interpretation of low-sun-angle aerial photographs and aerial reconnaissance, between Oroville and 6 miles south of the Yuba River, several linear topographic features (lineaments) were identified and named. Portions of these features occur within, and portions occur outside of the regional shear zone as it is shown on the Geologic Map of California, but they generally trend parallel to the structural grain of the area. From east to west they are the Paynes Peak, the Swain Ravine, and the Prairie Creek lineaments.(16) The Swain Ravine lineament, which passes through the Dry Creek damsite on a magnetic bearing of N 20° W, extends into the Cleveland Hill lineament at the Cleveland Hill crack zone which delineates the Cleveland Hill fault. The Prairie Creek lineament crosses the entire shear zone on a bearing of about N 30° W. It appears to truncate the Swain Ravine lineament about 7 miles south of the Yuba River from the Parks Bar damsite. The Paynes Peak lineament loses continuity about 0.6 to 0.7 mile east of the Swain Ravine lineament (in the vicinity of Lafferty, Johnson, and Paynes Peak) 8 miles northwest of the Parks Bar damsite.

Subsurface exploration of the main crack zones and lineaments was done by trenching at various times and places, as discussed below and shown on Figure H-1.

a. In August 1975, the California Department of Water Resources excavated four trenches (A,B,C, and D) across the Cleveland Hill crack zone. Three of the trenches exposed preexisting bedrock faults (Jurassic) with wide gouge zones directly beneath the surface cracks. The cracks could not be traced into the gouge or bedrock.

b. In January 1976, the U.S. Army Corps of Engineers excavated three trenches (Cleveland Hill Nos. 1 and 2, and Grubbs No. 1) across the Cleveland Hill and Mission Olive crack zones, under private contract, as part of a study to evaluate the potential for earthquakes and surface faulting at the afterbay damsite. These trenches exposed fault zones beneath, or near, surface cracks and contained evidence of at least three episodes of small scale vertical fault displacements totaling 18 inches, within the estimated age of the soil profile ranging from 5,000 to 100,000 years.(16)

c. From March to May 1976, PG&E excavated 17 trenches, across the main crack zones and major lineaments. Six trenches were across the crack zones: one trench, Cleveland Hill No. 3, was on the Cleveland Hill crack zone; and Sims No. 1, Lorraine Nos. 1, 2, and 3, and Grubbs No. 2 were on the Mission Olive crack zone. Results on those trenches were essentially the same as for the three Corps of Engineers' trenches noted above. The remaining 11 trenches were as follows: three on the Paynes Peak lineament (Knapp No. 1 and Burt Nos. 1 and 2), five at one locality on the Swain Ravine lineament

(Pace No. 1 to 5), and three on the Prairie Creek lineament (O'Brien No. 1 and Wilson Nos. 1 and 2). At most of these sites, shears or fault structures were exposed in the bedrock but none of those structures extended upward into overburden materials and no indication of recent movement was noted. Trenches Burt No. 2 and Wilson No. 2 were very short trenches excavated a few feet south of the No. 1 trenches to further inspect fault structures exposed in the No. 1 trenches. The Pace Nos. 1 to 5 trenches were all excavated in a N 65° E alignment with about 406 feet of trenches spread over approximately 550 lineal feet of ground. They explored features related to the Swain Ravine lineament.

d. In May 1976 the California Department of Water Resources excavated seven trenches across lineaments and ground cracks extending northward along the Mission Olive crack zone from Cleveland Hill toward the Bidwell Bar arm of Lake Oroville. One other trench was started but not completed or logged due to filling by water. Completed trenches were numbered 5, 7A, 7B, 8, 9, 10 and 11 from south to north. Three of the seven trenches (5, 7A, and 8) exposed fault structures which correlated with lineaments or surface cracks. No evidence of recent movement was determine in Nos. 5 and 7A but evidence for about 1/2 inch of movement prior to the 1975 earthquake was found in No. 8.

e. In July and August 1976 the U.S. Bureau of Reclamation excavated eight trenches, under private contract, in an area of ground cracks along the Swain Ravine lineament about 1-1/2 miles northwest of Bangor, California. Trenches were designated as Orange Avenue trenches A to H. Trenches excavated

across surface cracks showed the same relationship to bedrock fault structures as was found farther north at Cleveland Hill. Some bedrock shears and faults reportedly offset Cenozoic gravel deposits. In trench C, a fault with 13 to 14 feet of offset between metavolcanic bedrock and Cenozoic gravels was substantiated by data from drilling two NX diamond core holes. Details and final conclusions are not available at this time.

f. In August and September 1976, the U.S. Bureau of Reclamation excavated five trenches (Spenceville Nos. 1 to 5), under private contract, across the Prairie Creek lineament about 8-3/4 miles southeast of the Parks Bar damsite. The trenches exposed several southwest dipping shears and a bedrock fault feature with a wide clay gouge zone. The fault strikes N 45° W and dips 65° SW. At least one of several individual slickensided shear planes within the fault gouge extends upward into and apparently offsets the base of an overlying paleosol of undetermined age. Geological consultants for the U.S. Bureau of Reclamation have indicated possible recent movement on this fault. These trenches are south of the locality map.

g. In October and November 1976, the California Department of Water Resources excavated three additional trenches (Nos. 12, 13, and 14) across the Mission Olive crack zone from about 500 feet north of trench No. 8 to just south of Mt. Ida Road. Bedrock shear and fault features exposed had essentially the same relationship to ground cracks and lineaments as similar trenches to the south. No evidence of recent movement was determined.

The trenches discussed in subparagraphs a-g are listed by agency in the following tabulation.

COMPLETED TRENCHES
IN THE MARYSVILLE LAKE PROJECT AREA

Agency	Trenches	Location
State of California Department of Water Resources	A-D	Cleveland Hill crack zone
	Nos. 5-14	Mission Olive crack zone
PG&E	Cleveland Hill No. 3	Cleveland Hill crack zone
	Sims No. 1	Mission Olive crack zone
	Lorraine Nos. 1,2,3	Mission Olive crack zone
	Grubbs No. 2	Mission Olive crack zone
	Knapp No. 1	Paynes Peak lineament
	Burt Nos. 1,2	Paynes Peak lineament
	Pace Nos. 1-5	Swain Ravine lineament
	O'Brien No. 1	Prairie Creek lineament
	Wilson Nos. 1,2	Prairie Creek lineament
U.S. Bureau of Reclamation	Orange Avenue, A-H	Swain Ravine lineament
	Spenceville Nos. 1-5	Prairie Creek lineament
U.S. Army Corps of Engineers	Cleveland Hill Nos.1,2	Cleveland Hill crack zone
	Grubbs No. 1	Mission Olive crack zone
	4F-1 - 4F-5	Swain Ravine lineament

6. Geological investigations by the Corps of Engineers. -

Extensive geological field mapping and subsurface exploration by trenching was done between February and July 1976. During that time, trenches excavated by other agencies were inspected, and findings in this investigation were continually compared with those from other previous or current investigations.

a. Geological mapping. - Beginning in February 1976, geological mapping efforts were concentrated on the entire Marysville Lake project area, including the Yuba River, Dry Creek, and afterbay damsites and surrounding area. Rock types and structures were mapped, the major lineaments were traced through the project area, and a thorough search was made for evidence of surface cracks and recent faulting. The data were plotted on USGS 7-1/2 minute topographic base maps and special orthophoto maps at scales of 1"=400' and 1"=200'.

In May 1976, geologic reconnaissance mapping covered most of the regional shear zone extending between Auburn and Oroville, California. Numerous traverses were made along roads crossing the shear zone, and the data were plotted on USGS 7-1/2 minute topographic base maps. This mapping was done primarily to verify the location and extent of the shear zone and to correlate geologic units north and south with those in the project area.

b. Trenching. - Between 2 June and 8 July 1976 a series of five trenches were excavated (see tabulation at end of paragraph 5), along the Swain Ravine lineament. The purpose was to locate and identify geological features causing the lineament. Specifically, trenches were used to investigate fault structures associated with the lineament to assess the age of seismic activity within the project area, as well as to determine the relationship of the lineament to recent faulting on the Cleveland Hill fault. The trenches were designated 4F-1 to 4F-5, from north to south, and

were located 4.2 miles to 1.0 mile northwest from the Yuba River, respectively. All trenches were field located along the trend of the Swain Ravine lineament based on geologic structural indications such as an exposed bedrock fault, zones of intense foliation, and topographic saddles. The trenches were logged in detail at a scale of 1 inch equals 2 feet.

In summary, the trenches exposed weathered rock varying from massive to slightly, moderately, and highly foliated or sheared. Much of the rock was variably altered and showed evidence of complex structural deformation over a zone up to several hundred feet wide. There were many scattered thin shears, shear zones, and several fault structures, with different attitudes, which are assumed to be of Upper Jurassic age. Seven bedrock faults were identified, and six of them had clay gouge ranging from 0.1 to 1.4 feet in thickness. The gouge zones generally were thicker at the bedrock-soil contact than at the trench floor. No individual shear planes were found within the gouge zones. No fault-related structures extended upward into the overburden materials, and no evidence of Recent or even Quaternary fault movement was noted. Attitudes of five of the seven faults found ranged from strikes of N 5° to 32° W and dips of 41° to 75° NE. One fault strikes N 2° E and dips 52° SE, and the only westward dipping fault found strikes N 22° W and dips 48° SW. Insufficient structural relationships precluded determination of the relative direction of fault displacements except in trench 4F-1. There, drag fold structures indicated normal movement, down on the east side, for two subparallel faults striking N 5° to 15° W and dipping 41° to 47° NE.

7. <u>Results and tentative conclusions</u>. -

a. No evidence of ground cracking was observed during field investigations south of Bangor, California, and no evidence of Quaternary faulting was observed in trenches 4F-1 to 4F-5 or in the surrounding project area.

b. The Swain Ravine lineament appears to be a complex shear and fault zone consisting of several small roughly parallel, branching, and interlacing faults, numerous shear zones and thin shears, highly foliated zones, scattered intrusive dikes, and variously altered rock.

c. The sense of movement on bedrock faults observed in trenches north and south of the project area, along the Swain Ravine and other lineaments, was reported to be normal. Six of the seven faults exposed in Corps trenches dip eastward, whereas only one dips westward similar to the Cleveland Hill fault. Faults in the U.S. Bureau of Reclamation trenches northwest of Bangor (2-1/2 miles southeast of the Cleveland Hill fault and 13 miles northwest of trench 4F-1) dip both westward and eastward, as in the project area.

d. The possible association of the major lineaments within the regional shear zone with the overall Foothill fault system makes it reasonable to expect that regional adjustments, in the present tectonic regimen, will affect certain areas along these lineaments since they obviously represent zones of weakness within the bedrock complex.

e. Even though all the major lineaments appear to be old complex fault and shear zones, possibly associated with the overall Foothill fault system, they are not known to be active anywhere in the project area. Recent movement on the Cleveland Hill fault may have been restricted to a fault of limited extent in a complex zone of short branching and interlacing fault segments.

f. In agreement with other investigations, most of the fault and shear structures observed in trenches excavated across the major lineaments seem too small to account for the prominence and extent of the lineaments.

g. As noted in investigations by others, the approximately N 30° W alignment of the Palermo crack zone, between Palermo and South Oroville, California, is on trend with faults in the Pliocene Tuscan Formation north and east of Chico, California. It coincides with the Prairie Creek lineament along the western boundary of the regional shear zone, and has continuity through the afterbay damsite to the vicinity of Wellman Creek. This investigation suggests that it also continues southeastward on the same trend, through Austin Ravine and through the mile-long jog in Bear Creek, and continues along the eastern boundary of the shear zone to the Rocklin pluton. This lineament cuts across the entire structural trend of the regional shear zone and probably represents another complex through-going bedrock structure.

h. In agreement with Woodward-Clyde (April 1976) (17), reconnaissance mapping indicates that the location of the regional shear zone, shown on existing geologic maps, probably should be extended northward to include the

Cleveland Hill fault area. Also, there is reasonable evidence to suggest that it goes as far north as the Parish Camp Saddle Dam at Lake Oroville. It could be extended eastward in the vicinity of Bangor, California, to Paynes Peak, and about a mile westward, at the Yuba River, to include the area surrounding the afterbay damsite.

8. Soils. -

The project area contains six soil associations, shown on Figure H-2, described by Herbert and Begg (12) as:

Auburn-Sobrante-Las Posas

Redding-Corning

Sierra-Auberry

Wyman-Ryer

Englebright-Rescue

Tailings-Placer Diggings

Auburn-Sobrante-Las Posas Association - This soil association accounts for more than 80 percent of the soils in the foothills region of the

project area and is derived from metavolcanic rock. The soils are acidic loams and are brown to brick-red in color. They vary slightly in depth to bedrock, degree of profile development, and texture of the subsoil. The Auburn and Sobrante soils are dominant at lower elevations. Argonaut soils are intermingled with other soils at all elevations in localized spots.

Redding-Corning Association - This soil association borders the western edge of the foothills. It occurs on partially dissected remnants of old gravelly alluvial fans or terraces. Soils are developed in poorly-sorted gravelly and cobbly material containing a high percentage of quartzite and multi-colored chert gravels. They have a reddish-yellow, gravelly loam surface layer. Redding soils are characterized by a hardpan layer about 3 feet below the surface.

Sierra-Auberry Association - This soil association occurs only in one small portion of the study area, on the inside of Timbuctoo bend. Its soils are developed from granitic rocks. They are grayish-brown, pale brown, or brown in color, have acidic loam surface material, and are moderately deep. Rock outcrops are common.

Wyman-Ryer Association - This soil association occurs on nearly level, young alluvial fans east of the Feather River flood plain. The Wyman and Ryer soils are formed in alluvium mainly from basic metamorphic and igneous rocks. Both soils have loam to light clay loam surface layers that are brown to light reddish brown in color. The soils are deep to moderately deep, medium to moderately fine textured.

Englebright-Rescue Association - This association is located in the upper foothill region. The Englebright soils have a brown, medium acid, granular, loam surface soil and a reddish brown to yellowish red, medium acid, clay loam subsoil. The Rescue soils are similar but have weak, massive surface soil and are less acid. The association is composed of moderately deep to deep, medium textured, cobbly and rocky soils developed from basic igneous rocks.

Tailings-Placer Diggings Association - This soil association is a miscellaneous land type that occupies an extensive area along the lower Yuba River near Hammonton and a similar area in the lower foothills near Smartville. It consists of gravelly and cobbly mining debris (tailings) left by dredger and placer mining operations. Small fluvial deposits are also included in this association.

APPENDIX H

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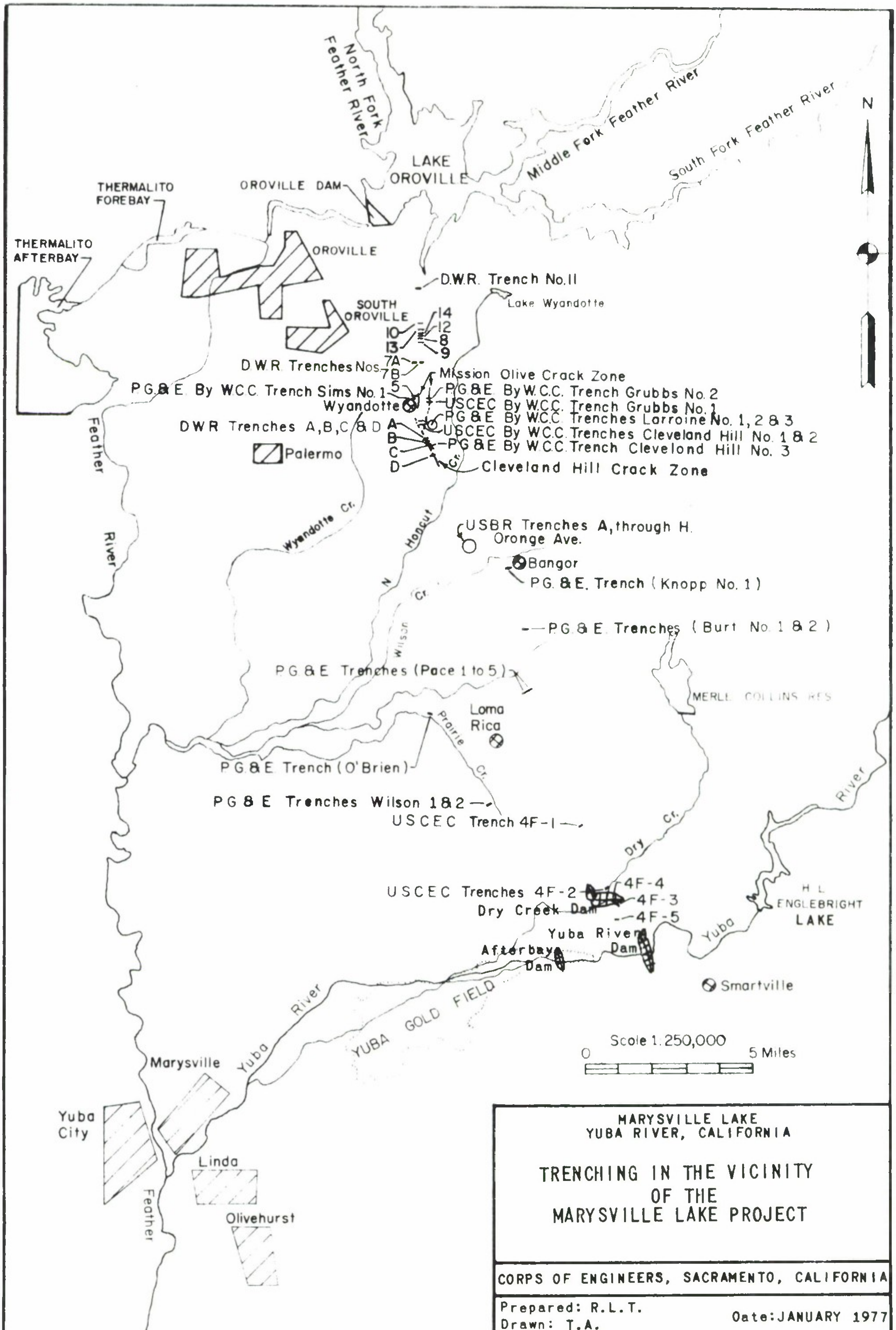


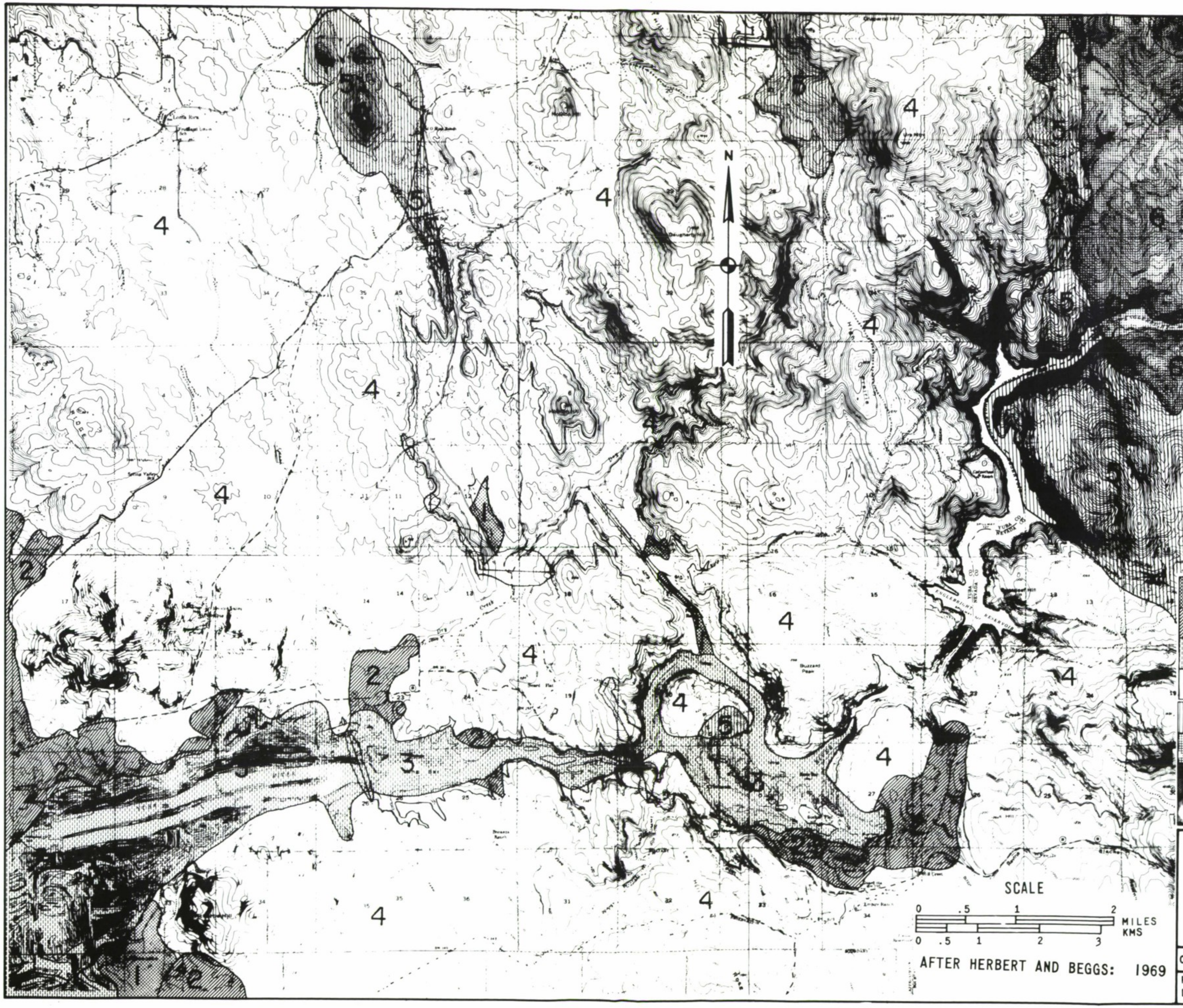
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

TRENCHING IN THE VICINITY OF THE MARYSVILLE LAKE PROJECT

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: R.L.T.
Drawn: T.A.
Date: JANUARY 1977

FIGURE H-1



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

SOILS OF THE PROJECT AREA

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE H-2

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX I - POWER

APPENDIX I - POWER

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APPENDIX I - POWER

1. General. -

California's electrical energy is supplied by a number of different types of generating facilities, most of which are connected to the major areas of demand by a common electrical transmission grid. Water orginally was the primary source of electric power in California, and early hydroelectric developments were usually single-purpose plants built by electric utility companies. In the late 1920's construction of stream generating capacity increased rapidly, and after World War II progressively larger steam-powered generating plants were constructed. Today hydroelectric power provides about 30 percent of the total energy requirements of the State. California's sources of electrical energy in recent years and as projected to 1985 are shown on Figure I-1. In 1972 Californians used approximately 155 billion kilowatt-hours (kWh) of electric energy, with hydroelectric generation in California supplying about 32 billion kWh annually. (9) Additional energy generated in hydroelectric plants outside the state is imported each year over transmission interconnections of the Pacific Northwest and plants on the lower Colorado River. (9) Total hydroelectrical generating capacity in California in 1972 was 8,162 megawatts (MW). (9)

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

The Yuba River basin now has seven hydroelectric facilities. These are Lake Spaulding on the South Yuba River with three plants totalling 17 MW of installed capacity, Deer Creek above Scotts Flat Reservoir on Deer Creek with 6 MW, Colgate Powerplant below New Bullards Bar Dam on the North Yuba River with 284 MW, and the Narrows and New Narrows Powerplants below Englebright Dam with 9 and 47 MW, respectively.

The U.S. consumed almost 69 million billion (69×10^{15}) Btu's of energy in 1971, while the annual rate of growth in total energy demand between 1950 and 1970 was about 3.6 percent. (16) However, electricity consumption grew at a rate of 7 percent annually between 1960 and 1970. (15) In 1971, 25.3 percent of total energy use was to generate electricity, and it has been estimated that by the year 2000 over 40 percent of all energy will be used to produce electricity.(16) In 1973, powerplants consumed the following portions of the U.S. primary energy resources.(13)

POWERPLANT PRIMARY ENERGY CONSUMPTION, 1973

Resource	Percent Consumed in Electricity Generation
Coal	64
Uranium	90
Hydro and geothermal	100
Oil and gas	13

Because there is no substantial capacity to store electricity, supply-demand relationships are measured in essentially instantaneous terms. Energy consumption (kWh) and peak capability (installed and available kW) are both important. Daily, weekly, and seasonal variations in load affect both of these and require that some power generation units be predominantly steady-state (baseload), while other units vary with load swings (cycling), and yet others are started up solely to meet short-term peak demands (peaking). Typical domestic variations in weekly electricity demand are shown in Figure I-2. In addition, there are wide variations in the hourly load and substantial changes in seasonal loads.

The capacity required to satisfy peak loads is greater than the base load, and any steps to make demand more uniform would make the overall generating system more economical. Utility economics govern the allocation of plant types to these various services.(13) Loading of the grid usually occurs by scheduling the largest and lowest-operating-cost generating units to serve the baseload energy requirements first and then adding smaller, less efficient units as required to meet the peak loads of variable duration. Hydroelectric power, despite minimal operating costs, is utilized more and more for peaking in many areas, because such capacity can be added economically even though overall generation is limited by fixed water storage. For peaking plants, high fuel cost is much less important than low capital cost; while in baseloaded plants, low operating cost is the important parameter rather than low capital cost.

Of the installed capacity today, large coal-fired power stations are predominantly base loaded, as are nuclear units. Oil- and gas-fired plants may serve as baseload sources in some parts of the country but more typically would serve a cycling function. Older coal-fired plants in some sectors of the country also serve the cycling function. In some areas gas turbines plus hydro units provide the peaking functions.

2. Plant types. -

a. Coal-fired plants. - While coal-fired units have supplied both base-load and cycling functions, modern coal-fired units have become more inflexible; and the largest units today provide mainly baseload power.(13) Growing particulate, sulfur, and nitrogen oxide stack gas emission controls have caused losses in both flexibility and availability. High degrees of superheat, high pressures, extreme water treatment, many stages of feedwater heating, cooling towers, precipitators, and SO^2 removal process equipment all have combined to make the modern coal-fired station a complex process plant.(13)

Some years ago, the promise of low fuel costs and the clean air aspects of nuclear plants began to attract attention, and the utilities foresaw a potential freedom from the month-to-month dependence on continued flow of coal from the mines and over the railroads. With strengthened environmental standards in the offing, new coal-fired plants began to suffer from serious inroads made by new nuclear plant orders and accelerating conversions to oil and gas firing.

As regulatory and equipment delivery delays began plaguing the nuclear construction program and the opposition to burning high-ash, high-sulfur coal gathered momentum, more orders went for oil-fired stations to fill the gap being rapidly created. The black-out in the Northeast in 1965 led to increased grid system interconnections, and the rising summer peak loads in later years led to greater numbers of gas turbine peaking units. All of these factors increased the moves toward gas and oil firing, until natural gas producers began to refuse to renew or make long-term gas contracts and until the 11-nation Organization of Petroleum Exporting Countries (OPEC) began serious oil price increases. The October 1973 oil embargo turned many utilities back toward coal firing and, because of air pollution regulations, toward western low-sulfur coals.

Since the mid-1960's, a number of coal-fired stations have been converted to oil firing. These changes occurred at first because of economics, but accelerated later because of stack gas emission standards regarding sulfur. Some 400 units amounting to about 30 GW have been converted to oil in the past 10 years, and about 20 percent of these have either sold off their coal storage pile land, built additional units on the land, and/or removed coal- and ash-handling equipment.(13) The result is that these latter conversions are essentially irreversible now. In addition, there are existing units that, although they still have multiple fuel-burning capability, cannot obtain approval to revert to

coal firing because of environmental regulations. Because the law requires use of the "best possible technology," there has occasionally been a refusal to allow coal burning of any sort, including low-sulfur coal, even though the sulfur content may be nearly the same as that of the oil currently being burned.

Rapid expansion in installation of new coal-fired stations is hindered by some of the same problems that nuclear units encounter, namely, lack of water cooling, lack of approved sites, and restrictions on environmental emissions. Even in entirely rural areas and in well-ventilated air basins, coal-fired powerplants are required to employ the same emission control standards and SO^2 removal processes that urban power stations are required to use.

b. Nuclear plants. - After more than 30 years of research, development, and large-scale demonstrations, nuclear powerplants are now being utilized on an increasing scale by electric utilities in the United States. Almost all nuclear units are so-called light-water reactors, although gas-cooled reactors are receiving increasing attention.

Atomic Energy Commission (AEC) forecasts project that under most likely conditions only about 100 GW of nuclear power will be in operation by the end of 1980, and only about 250 GW by 1985.(13) Five years ago about 6 years were required from inception to on-line power generation for nuclear units; however, lead times for new nuclear units have now increased to 9 to 10 years. The status of nuclear powerplants in 1973 was as follows.(13)

	Capacity GW
Units with operating licenses	25
Awaiting operating licenses	30
Construction permits granted and under construction	23
Construction permits pending and under design	60
Announced, but applications not yet filed	50
Planned, but not announced	ca. 20
Total	208

The Task Force on Energy of the National Academy of Engineering concluded that any policy seeking to minimize dependence on imports and to conserve fossil fuels clearly must consider assigning a high priority to the acceleration of the installation of nuclear plants.(13) One of the serious problems of the nuclear power industry is the AEC licensing process, which had their origins in the early days of rapidly developing and changing nuclear technology. If the licensing problem can be ameliorated by more efficient procedures, the Task Force believes that about 125 GW might realistically be expected to be operating by the end of 1980, and that a determined effort could lead to 325 GW being in operation by the end of 1985. This would displace the equivalent of about 8 million barrels per day (MBPD) of oil by 1985.(13)

ESTIMATED 1985 NUCLEAR POWER CAPACITY

Type	1974-1985 Additions GW	1985 Capacity GW
Light water reactors	+280	305
Gas-cooled reactors	+ 20±	20±
Breeder reactors	Nil	Nil
Total	+300	325

Rapid growth of nuclear power involves many questions relating to nuclear fuel--the provision of adequate supplies of fuel, usually as low-enrichment uranium dioxide clad in zirconium, and disposition of spent fuel, usually involving storage and transport to a reprocessing plant where the uranium, plutonium, and radioactive wastes are separated. In addition, there are questions not only with respect to storage and disposal of radioactive wastes, but also with safeguards against theft of fissionable or highly radioactive materials.

The rate of uranium exploration has been very low, largely because of the depressed market. Utilities have failed to enter into long-term contracts for uranium which, taken with the long payout combined with high interest rates, have made speculative prospecting an unattractive gamble.(13) The importation of uranium would not be consistent with a concept of self-sufficiency, and there are serious questions as to the amount of uranium that may be available for import, because nuclear power

is growing rapidly in the rest of the world--at a rate about equal to that in the United States. With 325 GW in operation at the end of 1985, uranium requirements in 1985 would be about 80,000 tons, assuming use of plutonium recycle. Production would need to be more than quadrupled by 1985 over the maximum ever achieved in the United States.

The enrichment of uranium from the 0.71 percent natural U235 content to the roughly 3 percent needed in light-water reactors requires large and expensive facilities that, if based on the diffusion process used to date, also require large amounts of electric power. The investments required and the amounts of power needed are very large for each single project, requiring on the order of $2 billion each and power supplies of about 2,500 MW for a gaseous diffusion enrichment plant.

The Task Committee concluded that management of radioactive wastes, including storage and disposal, does not appear to be a serious constraint on the growth of the industry. While radioactive wastes are hazardous and must be stored for long periods of time, large amounts have been handled safely for long periods; and new storage methods are being developed that should improve on the past record. Long-term (100-year) interim and retrievable storage now being developed by the AEC will permit storing wastes produced through the year 2000 on a desert tract of 100 to 2,300 acres, depending on the concept selected, and at a cost of less than 0.5 percent of the cost of producing the related power.(13) Permanent disposal in geologic formations appears feasible and attractive

but still needs adequate demonstration. Similarly, the safety of transport of irradiated nuclear fuel has been very high, and the conditions are even better for radioactive wastes that are allowed to cool for several years and then converted to solid form.

One area of increasing public concern is the problem of preventing the theft of fissionable or highly radioactive material. The problem is primarily associated with reprocessing facilities and those fuel fabrication facilities using highly enriched uranium or plutonium. Fuel in powerplants is of low enrichment, clad in zirconium, and usually in large heavy assemblies, and not of the type that might be attractive.

c. Oil- and gas-fired plants. - There are many oil- and gas-fired units in base load operation in some areas of the nation. While it might be desirable to decrease natural gas use for base load purposes, oil-fired units must be utilized for many years to come, particularly in cycling and peaking service. However, the lower the load factor, the less fuel these plants consume. The function of oil- and gas-fired plants in the future probably should be to provide cycling and peaking capability, not base load energy.(13)

It is not practical to convert existing oil- and gas-fired units to coal, since they have no provisions for coal storage, coal and ash handling, precipitators, or SO^2 removal equipment. Furthermore, the furnaces are too small for handling pulverized coal, and the plants would

have to be derated. Gas-fired units could possibly be converted to burn medium-Btu gas from coal; however, the cost of manufacturing and transporting such gas is economically unattractive compared with natural gas, if natural gas is reasonably available. The alternative is to relegate natural-gas-fired units more and more only to providing peaking capacity. It therefore remains for nuclear and coal-fired units to supply the bulk of new base load power.(13)

d. Hydroelectric plants. - Hydroelectric power is generated by the gravitational flow of water, converting natural energy inherent in the water to mechanical energy by a turbine, and then to electrical energy by a generator. Hydropower is a finite resource in a given river basin, with the potential determined by the magnitude of the drainage basin runoff and the topography of the basin.

The electrical energy market whose operational requirements are most compatible with the operational capabilities and limitations of most conventional and all pumped storage hydro is at the peak of the load curve, when the marginal 10-15 percent of maximum capacity and generational demand occurs. The incremental cost of supplying this low load factor demand from thermal sources is substantially higher than the cost of meeting demand at lower positions on the load curve. Hence it is a high value market for hydropower.

In terms of economic efficiency, hydropower has two inherent advantages over thermal power. The useful life of structures is estimated at 100 years for economic analysis purposes, compared with 30 to 35 years for thermal plant and equipment; it consumes no fuel, a major cost item for thermal power generation; and its other operation and maintenance costs tend to be lower because equipment tends to be less complex. Another advantage is its capability of almost instantaneous response to increased load demands. These inherent advantages have historically been partially offset by the fact that initial investment costs per unit of capacity have been greater than for thermal plant and equipment. But that is now being offset by the sharp increases in investment costs associated with the siting and construction of fossil fuel and nuclear plant, including cost increases associated with equipment and operating costs for air and water pollution control. Radical increases in fossil fuel costs in recent years also increase the relative economic efficiency of hydropower as a source of electrical energy.

Pumped storage is an ideal source of peaking power, because of its quick response to change in power demand, and because it uses off-peak power for pumping. Pumped storage may be developed at conventional hydropower reservoirs or it may be located at any place where there is an adequate supply of water for pumping into storage, adjacent to an area suitable for development as a pumped storage reservoir. In either case, thermal-electric energy is normally used for pumping. Pumped storage hydropower involves a net loss of energy. The amount of energy required

to pump water to a higher level for the generation of hydroelectricity is on the average, approximately 1.5 times the energy produced. The most economic source of pumping energy is baseload capacity not utilized during offpeak periods. With present technology, this may be either nuclear or fossil fuel fired steam plants. These have the highest capital costs as well as the highest efficiency in the use of fuels. Incremental costs of generation during offpeak periods are extremely low, relative to the costs of generating peaking power from gas turbines. Hence, in those areas where pumped storage hydropower resources are available as a source of peaking power, the use of unutilized baseload capacity in offpeak periods results in more efficient use of existing plants.

3. Electric energy storage. -

Since high-voltage, alternating-current electricity cannot be stored it must be converted to other forms before storage, such as water storage, compressed air storage, and batteries. The two major mechanical schemes absorb excess electricity during offpeak hours by pumping working fluids to a higher energy state (elevation, pressure) and returning electrical energy to the grid during peak demand hours, usually morning and evening. Pumped-storage schemes are energy absorbers and capacity producers. Therefore, while they fulfill a vital function to baseloaded units on the system, they are in fact energy-consuming units. For this reason, they are important and valuable adjuncts principally to coal-fired and nuclear-generating units. The Task Force on Energy of the National

Academy of Engineering estimates that about 45 GW of pumped storage units can be expected by 1985.(13)

If the estimated nuclear and coal-fired powerplant programs described earlier are achieved, a total of about 500 GW of essentially base-loaded capacity will be installed out of a total of roughly 1,000 GW in 1985. Unless something dramatic occurs in consumer demand to improve overall load factors, this base load capacity would be too much. Hence, of the total 330 GW of coal-fired capacity, about 130 GW is expected to be relegated to cyclic load. In addition, about 45 GW of pumped-storage units could be used plus perhaps another 50 GW cycling capability from the nuclear plants that came on-line in the 1970 to 1975 period. Since there is about 8 GW of pumped-storage capability today, this estimate represents the addition of an average of 18 new 200-MW pumped-storage systems every year for 10 years.(13)

4. Conservation and load management. -

Conservation in the use of electric energy is one means of reducing the demand for electric power and, thereby, the need for new generating facilities. To date, most conservation measures have been voluntary and have been implemented by public education methods or Federal programs. Examples are: encouraging the use of major appliances during other than peak hours, lowering the thermostat setting on heating units, and raising the thermostat setting on air conditioning units. Other conservation

methods could be implemented, such as: wider use of insulation, energy consciousness in the design and construction of homes and offices, and the manufacture of energy efficient equipment.(2)

According to a report of the Institute of Electrical and Electronics Engineers (IEEE)(3)(Ad Hoc) Energy Forecast Working Group, usage of electricity in the United States dropped off markedly after the Middle East oil embargo, showing a sudden drop in November 1973. The recent economic recession in the United States and use of energy conservation measures were identified as the two main factors causing the drop in consumption. However, the influence of conservation has been very short-term, and with the effect of the recession lessening, the rate of growth in electricity consumption is observed to be returning to pre-embargo levels. This suggests that voluntary conservation, in its present form and current effectiveness, is unlikely to significantly affect the future rate of growth in power demands.

Rate revision has been advocated as a means of accomplishing conservation. As an example, the California Public Utilities Commission issued two orders early in 1976 that indicate the new direction their regulatory activities will take to promote energy conservation. One order noted that the rate structure for consumers of electric energy would be changed so that larger users would pay a higher rate, rather than a lower rate. The other order requested Pacific Gas and Electric Company (PG&E) to identify a type of metering system that could record

use in peak hours, as well as total use, as a prerequisite to establishing a differential rate structure. The hourly, daily, and seasonal variation in load is associated with varying costs. There are costs of having rates which vary over time, such as more complex meters, but to the extent that the benefits of peak load pricing exceed its costs, there is a basis for electric rates reflecting variation in system costs during the day and during the year. Most retail electric rate schedules reflect primarily average running costs and average historical capacity costs. Thus, at peak demand periods the price of electricity may be too low compared to the costs of supplying electricity at such times. The extent to which peak load pricing can be economically justified for any given system depends in part on: (a) customer responses to a revised rate structure, (b) the load characteristics of the system, (c) the ability of the system to flatten its load curve by way of intersystem sales, and (d) the costs and inconvenience of new metering and billing.(1) Studies of the responsiveness of demand to price changes (price elasticity of demand) have not produced uniform results.

Several studies are underway in California to determine customer response to time varying rates, including a project being conducted by the Los Angeles Department of Water and Power and Rand Corporation, and a project cosponsored by the State of California Energy Resources Conservation and Development Commission (ERCDC), the Public Utilities Commission (PUC), and the 4 major California utilities. In Decision No. 85559, the PUC ordered immediate implementation of time-of-day rates

where substantially all metering equipment is in place, and implementation of time-of-day rates to the 500 kW customer level within one year. Below the 500 kW level, the PUC ordered experimentation with time-of-day rates to determine if the benefits outweigh the costs.

Rate structures also may be designed to reduce peak demand without significantly affecting energy use. However, it should be noted that any reduction in capital expenditures for new generating capacity by delaying or retarding peak load growth may be somewhat offset by inflation (assuming that the rate of increase in construction costs exceeds return on alternative investments).

Demand probably is somewhat responsive to price in the long run (i.e., several years), but limited in response during shorter periods. Commercial and industrial customers have a sunk investment in electric and non-electric equipment. Operating existing equipment at higher electric rates may be less expensive than investing in more efficient equipment even though it may involve lower operating costs.

A major study of time-of-day metering and load management systems by the Edison Electric Institute and the Electric Power Research Institute has been undertaken at the request of the National Association of Regulatory Commissioners (NARUC).(8) In addition, several studies of rate revision and load management methods are being sponsored by the Federal Energy Administration. Moreover, many regulatory commissions and

utilities are studying the potential effects of rate revisions on demands for electric power.

The uncertainties of the effects of specific rate redesigns and other conservation measures on the load characteristics of an electric system, the time lag associated with consumer responses, and the long times required for constructing new capacity severely reduce the practical potential of rate revision and conservation as alternatives, at this time, to the scheduling of projected needed additional generating capacity. Accordingly, these measures cannot be considered as reasonable alternatives.

Conservation may also be achieved by improving an electrical system's ability to meet peak demands without a reduction in total load. A measure of the degree of variation in electrical demand is the system's load factor, which is the ratio of average annual demand to annual peak demand. Reshaping the load curve to minimize variation is termed load management. The 1975 load factor for the PG&E system was 62 percent, and for the Sacramento Municipal Utility District (SMUD) the load factor in 1975 was 42 percent. The average load factor in the United States in 1975 was about 61 percent.

Both conservation and load management are of interest to the California ERCDC which has reviewed methods which might be utilized to level out the demand for electricity. The staff has recommended that the

Commission adopt the position of requiring utilities to demonstrate that they have given alternatives for leveling out the load curve serious consideration.

The Federal Energy Administration has the objective of increasing the load factor to 69 percent in 1985.(14) It appears that load factors higher than 69 percent probably cannot be obtained in a practicable manner and that there will continue to be a need for peaking power.

5. Estimates of electrical energy demand in California. -

A California Resources Agency study, dated March 1974, indicates that the demand for electricity was expected to increase in California by 229 percent between 1972 and 1985.(9) The California PUC in a report dated October 1973, indicated the expected increase in hydroelectric generating capacity to be 42 percent over the 10-year period ending in 1982.(11) This projected increase is less than those for other types of generating facilities because of the decreasing availability of suitable hydroelectric power facility sites. The growing demand for electricity and shortage of fuel for thermal plants are expected to cause an increase in price for electricity. Various measures to conserve the use of energy, and in particular electrical energy, are under study by the State ERCDC and others. Government policies may be implemented to use electricity price increases as a means of energy conservation. In addition, the utilities may introduce differential pricing for peak and base load power.

The higher prices for peak load power may tend to make hydroelectric projects more attractive economically because they are suited for peak load operation.

The historical increase in peak capacity demand for the period 1940-1972 is shown on Figure I-3. Projections of future needs for peaking capacity in California made by public utilities in 1973 and in August 1976 are shown on Figure I-4. The 1976 utility capacity projection, which was based on lower population projections and more refined procedures for forecasting peak demands than their 1973 projection, indicates the need for peaking capacity in 1990 to be 32,000 MW less than indicated by their 1973 projection, a significant reduction. The projection by the staff of the ERCDC, presented in their October 1976 report (10) and based on somewhat different projection techniques than those used by the utilities and implementation of conservation measures, is also presented on Figure I-4. The ERCDC projection indicates lower future capacity needs than the utilities projection, but even the ERCDC projection indicates the need for substantial additions to present peaking capacity to meet future demands, as follows:

Year	Capacity (MW)	Increase (MW)
1975	28,800 (1)	
		17,700
1990	46,500	
		3,300
1993	49,800	
		3,500
1995	53,300	

(1) Actual.

Typical load curves indicate that peak energy demand is about twice the load for the hours immediately after midnight, as shown on Figure I-2. To supply the energy needed to meet peak demand, units such as hydroelectric and gas turbine, which can start and stop rapidly, are used to augment baseload plants, permitting thermal and nuclear plants to run at a more efficient continuous rate.

The 1976 utilities and ERCDC projections of future needs for energy are shown on Figure I-5. Again the ERCDC projection is substantially lower than the projection by utilities; however, the ERCDC projection indicates the need for energy in 1995 will essentially double the need in 1975, as follows:

Year	Energy (millions of kWh)	Increase (millions of kWh)
1975	137,000	
		91,000
1990	228,000	
		23,000
1993	251,000	
		16,000
1995	267,000	

An older report by the California Resources Agency (12), that indicated that California would need about 72,700 MW of new generating capacity (over the 1972 capacity) in order to meet the projected 1991 demand, indicated this additional capacity was expected to be provided about as follows:

Type	Capacity in MW
Hydroelectric	8,000
Geothermal	7,200
Coal-fired (from neighboring states)	6,900
Gas- and oil-fired	10,600
Nuclear	40,000
Total	72,700

6. Western Systems Coordinating Council. -

a. General. - Because of the interconnection between bulk power systems in the West, it is not possible to consider the isolated case of power capacity resources, energy production, and loads in California. Initially, the entire coordinated Western Systems Coordinating Council (WSCC) must be considered. The WSCC is a voluntary organization of utilities providing substantially all the electric service in the 14 western states and British Columbia. The WSCC area is shown on Figure I-6. The WSCC consists of 4 subreaches: the Northwest Power Pool, Rocky Mountain Power Area, New Mexico Power Pool, and the Pacific Southwest Power Area which is subdivided into 4 areas. Northern California is in Sub-Area D of the Southwest Power Area.

b. Generating resources. - Figure I-7 shows the breakdown of generating resources in the WSCC by resource type as of December 1974 and the Council's projected significant additions through 1984 by

resource type. Existing generating resources and projected significant additions in Sub-Area D of the Pacific Southwest Power Area are shown in the next tabulation.(17)

Resource Type	Existing Capacity (MW)
Fossil - Coal	0
Fossil - Gas or Oil	7,954
Nuclear	976
Hydro	7,229
Hydro - Pumped Storage	0
Combustion Turbine	36
Diesel	52
Combined Cycle	0
Geothermal	502
Other	0
Total	16,749
Percent of WSCC Total	18.1

WSCC projections of significant additions to generating resources in Sub-Area D discussed above are shown by years in MW in the next tabulation.(17)

RESOURCE TYPE	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	10-YR. PERIOD	PERCENT OF TOTAL
FOSSIL - COAL	0	0	0	0	250	0	0	250	0	250	750	7.0
FOSSIL - GAS OR OIL	0	0	0	0	0	-116	0	0	0	0	-116	-1.1
NUCLEAR	1060	1060	80	70	0	0	0	0	0	1100	3370	31.6
HYDRO	-26	0	0	300	0	0	6	392	150	0	822	7.7
HYDRO-PUMP STORAGE	0	0	0	0	0	1125	0	0	0	0	1125	10.6
COMBUSTION TURBINE	225	171	167	0	707	-240	75	375	675	0	2155	20.2
DIESEL	0	0	0	0	0	0	0	0	0	0	0	0
COMBINED CYCLE	0	0	0	0	0	360	0	0	0	0	360	3.4
GEOTHERMAL	0	0	271	135	220	110	220	110	220	110	1396	13.1
UNDEFINED	0	0	0	0	0	0	0	800[a]	0	0	800	7.5
TOTAL	1259	1231	518	505	1177	1239	301	1927	1045	1460	10662	100.0

(a) STEAM CYCLE UNIT FUELED EITHER BY OIL OR COAL.

These projected additions are as follows.

- Fossil; coal. - Sierra Pacific Power Company is planning the addition of three 250 MW coal-fired units, two at Valmy, Nevada and one at a site presently undetermined.

- Nuclear. - Diablo Canyon 1 and 2 (1060 MW), which are owned by PG&E, will go into operation in 1976 and 1977. Planned up-ratings of these two units will bring their capacities to 1100 MW in 1978 and to 1120 and 1150 in 1979. PG&E plans a 1100 MW unit for 1985 in California.

- Hydro; pumped storage. - PG&E has a 1125 MW pumped storage project planned for June 1981 operation located at Lake Wishon on the North Fork of Kings River, plans a new 130 MW unit at the Kerckhoff plant on the San Joaquin River in 1983 to replace an existing 38 MW unit, and a new 150 MW plant located somewhere in California in 1984. The USBR has two 300 MW plants associated with flood control and water supply developments; one at New Melones Reservoir in 1979 and the other at Auburn Reservoir in 1983.

- Combustion turbine. - PG&E is planning four 52 MW and one 17 MW units in San Francisco in 1976, three 57 MW units in Oakland in 1977, and one mobile 17 MW emergency unit in Richmond in 1978. SMUD plans a 150 MW plant at an unknown location in 1978. PG&E plans two 225 MW units in the

San Francisco Bay area, one mobile 17 MW emergency unit in California, and one 240 MW unit in San Francisco in 1980; one 75 MW unit in the Bay area in 1982; five 75 MW units in the Bay area in 1983; and a 300 MW installation in the Bay area and a 375 MW plant at an unknown site in California in 1984.

- Combined cycle. - PG&E is planning a 360 MW combined cycle unit to increase San Francisco's power supply and permit the retirement of 116 MW of old thermal capacity in 1981.

- Geothermal. - All geothermal capacity is planned to be located at or near the existing Geysers development in Northern California. Additional exploration is needed to confirm adequate steam for units being planned for 1979 and beyond.

c. Firm peak loads. - WSCC estimates of firm peak loads in Sub-Area D for the period 1975 through 1984 are shown by years for summer and winter conditions in the next tabulation for adverse hydro conditions.(17)

SUMMER — ADVERSE HYDRO CONDITIONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Firm Load - MW	14215	15136	16092	17127	18111	19150	20226	21380	22698	24039
Growth Rate from Previous Yr.		6.5	6.3	6.4	5.7	5.7	5.6	5.7	6.2	5.9
Resources ± Transfers - MW	17200	18573	19820	20178	20517	21620	23136	24019	25774	27844
Scheduled Maintenance - MW	0	0	0	0	0	0	0	0	0	0
Reserve Capacity										
MW	2985	3437	3728	3051	2406	2470	2910	2639	3076	3805
Percent of Firm Load	21.0	22.7	23.2	17.8	13.3	12.9	14.4	12.3	13.6	15.8

WINTER — ADVERSE HYDRO CONDITIONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Firm Load - MW	12772	13622	14481	15433	16354	17351	18387	19441	20634	21847
Growth Rate from Previous Yr.		6.7	6.3	6.6	6.0	6.1	6.0	5.7	6.1	5.9
Resources ± Transfers - MW	16226	17403	18913	19137	19461	20811	22084	23098	24856	26698
Scheduled Maintenance - MW	80	0	0	0	0	0	0	0	0	0
Reserve Capacity										
MW	3374	3781	4432	3704	3107	3460	3697	3657	4222	4851
Percent of Firm Load	26.4	27.8	30.6	24.0	19.0	19.9	20.1	18.8	20.5	22.2

d. Projected sources of thermal energy production. - The next tabulation shows the WSCC projection of sources of thermal energy production and the fossil fuel requirements in Sub-Area D for both average and adverse hydro conditions.(17)

AVERAGE HYDRO CONDITIONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
THERMAL ENERGY - AVERAGE MW										
RESOURCES - LIMITED BY PLANT AVAILABILITY AND LOAD CHARACTERISTICS DEDUCTING SCHEDULED MAINTENANCE										
Nuclear	691	1352	2200	2395	2651	2718	2730	2761	3249	4281
Geothermal	404	433	540	726	839	916	1028	1105	1216	1293
Coal	0	0	0	0	0	50	150	200	350	450
Gas and Oil	3695	3642	3245	3455	3609	3856	4122	4958	4989	4568
Total	4790	5427	5985	6576	7099	7540	8030	9024	9804	10592
FOSSIL FUEL REQUIREMENTS - COAL IN TENS OF THOUSANDS OF TONS, OIL IN TENS OF THOUSANDS OF BARRELS, GAS IN TENS OF THOUSANDS OF EQUIVALENT OIL BARRELS										
Coal	0	0	0	0	0	18	55	74	129	166
Gas and Oil	4845	4868	4354	4684	4926	5288	5542	6758	6838	6245
Gas Availability	1 575	903	483	251	169	157	149	141	134	127
Oil Burn Required	3270	3965	3871	4433	4757	5131	5393	6617	6704	6118
Amount of Oil Burn estimated to be distillate	4	33	44	41	45	103	310	308	308	308

ADVERSE HYDRO CONDITIONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
THERMAL ENERGY - AVERAGE MW										
RESOURCES - LIMITED BY PLANT AVAILABILITY AND LOAD CHARACTERISTICS DEDUCTING SCHEDULED MAINTENANCE										
Nuclear	691	1352	2200	2395	2651	2718	2730	2761	3249	4281
Geothermal	404	433	540	726	839	916	1028	1105	1216	1293
Coal	0	0	0	0	0	50	150	200	350	450
Gas and Oil	4600	4543	4135	4343	4498	4764	5029	5871	5847	5402
Total	5695	6328	6875	7464	7988	8448	8937	9937	10662	11426
FOSSIL FUEL REQUIREMENTS - COAL IN TENS OF THOUSANDS OF TONS, OIL IN TENS OF THOUSANDS OF BARRELS, GAS IN TENS OF THOUSANDS OF EQUIVALENT OIL BARRELS										
Coal	0	0	0	0	0	18	55	74	129	166
Gas and Oil	5999	6042	5521	5866	6119	6514	6752	7996	8010	7380
Gas Availability	1575	903	483	251	169	157	149	141	134	127
Oil Burn Required	4424	5139	5038	5615	5950	6357	6603	7855	7876	7253
Amount of Oil Burn Estimated to be Distillate	4	33	44	41	45	103	310	308	308	308

For average hydro conditions, the WSCC estimates the energy sources to be as follows in 1975 and 1984.(17)

Source	1975	1984
Coal	17%	26%
Gas	7%	1%
Oil	23%	19%
Nuclear	4%	22%
Hydro	48%	30%
Geothermal	1%	2%

Projections by WSCC of energy sources by years are shown graphically on Figure I-1. The data on both Figure I-1 and I-7 indicate that an increasingly larger percentage of the load will be served by coal, nuclear, and geothermal sources. The WSCC projects that for average hydro conditions the oil burn required to satisfy projected energy generation demands increases from 140 million barrels in 1975 to 1982 when it peaks at 206 million barrels.(17) The maximum oil burn requirement for adverse hydro conditions is currently estimated to occur in 1982 at 230 million barrels.(17) Delays in planned coal or nuclear capacity or reductions in energy production from these resources will increase estimated oil fired energy requirements. The WSCC projects that California and Nevada systems will burn approximately 90 percent of the estimated WSCC (excluding Canadian systems) oil requirement. Projected oil requirements for Sub-Area D are shown in the next tabulation for average and adverse hydro conditions.

Year	Oil Burn (MBPY) Average Hydro Conditions	Adverse Hydro Conditions
1975	33	44
1976	40	51
1977	39	50
1978	44	56
1979	48	60
1980	51	64
1981	54	66
1982	66	79
1983	67	79
1984	61	73

e. Transfers. - Data from the WSCC (17) indicate that there are currently significant transfers of capacity and energy into and out of Sub-Area D. Firm transfers between Sub-Area D and the Northwest Power Pool include:

- Columbia Storage Power Exchange capacity and energy purchased by PG&E, SMUD and the California State Department of Water Resources.

- Capacity and energy purchased by the USBR-MP Region for the Central Valley Project in California.

- Sierra Pacific Power Company capacity and energy purchases from Utah Power & Light Company.

- PG&E purchase of summer peaking capacity from Portland General Electric Company and Bonneville Power Administration.

- Mount Wheeler purchase from USBR-UC Region (USUC) which is wheeled by Utah Power & Light Company.

- Portland General Electric Company purchase of winter capacity from Pacific Gas & Electric Company during 1975.

Firm transfers between Sub-Area D and Sub-Area A include:

- Oroville-Thermalito power purchased by Southern California Edison and San Diego Gas & Electric Companies from the California State Department of Water Resources which is wheeled by PG&E.

- Power transfers associated with operation of the California State Water Project which crosses the boundaries of Sub-Areas A, B, and D of the Pacific Southwest Power Area.

Firm transfers between Sub-Area D and Sub-Area B include power transfers associated with the San Joaquin Nuclear project.

7. Federal Power Commission studies. -

a. Power values. - In response to a request from the U.S. Bureau of Reclamation (USBR), the Federal Power Commission (FPC) computed hydroelectric power values based on 1 January 1976 price levels, a range of capacity

factors, and for three types of financing (Federal financing using 3-1/4 and 6-1/8 percent interest rates and composite financing based on 80 percent private and 20 percent public-non-Federal financing). A 10 percent cost of money was assumed for private financing and 6-3/4 percent rate of interest was used for public-non-Federal financing. These data were furnished to the USBR by FPC letter dated 16 July 1976, included in Appendix B.

The FPC power values are at-market, include hydro-thermal capacity and energy value adjustments, and are based on the estimated costs of the three alternative sources described below.

- Nuclear-fired steam-electric plant with 2,000 MW total capacity consisting of two 1,000 MW units operating at a 65 percent average annual capacity factor; heat rate, 10,500 Btu/kWh; capital cost, $570 per kW; service life, 30 years; fuel inventory, $50 per kilowatt; and fuel energy cost, 3.0 mills per kWh.

- Combined cycle generating plant with 710 MW total capacity consisting of two 355 MW units, four combustion turbines and one steam turbine per unit operating at a 25 percent average annual capacity factor; heat rate, 9,000 Btu/kWh; capital cost, $250 per kW; service life, 30 years; and low sulfur oil cost of $2.25 per million Btu.

- Combustion turbine generating plant with 568 MW total capacity consisting of four 142 MW units operating at a 7.5 percent average annual capacity factor; heat rate, 13,000 Btu/kWh; capital cost, $135 per kW; service life, 30 years and low sulfur oil cost of $2.25 per million Btu.

The power values for a combustion turbine generating plant with an annual capacity factor of 10 percent and for composite 80 percent Federal and 20 percent public-non-Federal financing, based on 1 January 1976 price levels are as follows:

Capacity - $26.89 /kW-yr

Energy - 28.97 mills/kWh

b. Source of offpeak pumping energy. - The FPC indicated in 1976 that the source of offpeak energy for pumping would probably be nuclear-fired generating plants after 1990 with a cost of 3.24 mills/kWh for this energy, based on 1 January 1976 price levels. (The FPC noted that the cost of offpeak energy as of 1 January 1976 was 17.18 mills/kWh.) However, by letter dated 1 February 1977, included in Appendix B, the FPC indicated that pumping energy would be available only from fossil-fueled steamplants through 1993 (at a estimated cost of 21.78 mills/kWh) and that after 1993 the most probable source of pumping energy is nuclear-fired generating plants (at a cost of 3.24 mills/kWh). It should be noted that the Marysville Lake project is projected to be completed in 1990, but it is estimated 3 years would be required for the reservoir to fill and the powerplant to operate at full capacity. The FPC 1 February 1977 letter

was received subsequent to conduct of the operation studies reported in this Design Memorandum, but because the powerplant is not operating at full capacity prior to 1993, the change in cost of offpeak pumping prior to 1993 would have little effect on the cost-benefit analysis.

c. Need for power. - The FPC conducted studies in 1976 and January 1977 of the need for additional system peaking capability in the 1990's in FPC Power Supply Area 46. Results of the study are summarized in letters from the FPC to Sacramento District, dated 26 July 1976, 24 August 1976, and 1 February 1977, included in Appendix B. Estimated loads used in the study were from those developed for the WSCC and shown in its "Reply to Federal Power Commission Docket R-362, Order 383-3," dated 1 April 1976. The study area is the "Pacific Southwest Power area, Sub-Area D," which approximates Power Supply Area 46. WSCC projections of capacity and energy for Sub-Area D are shown on Figures I-4 and I-5. The following tabulation shows the FPC's estimated loads in the early 1990's. (The Marysville Lake project is projected to become fully operational in 1993.)

Estimated Annual Load Requirements

Year	Peak Demand MW	Energy GWh
1990 1/	31,000	161,800
1	32,500	169,700
2	34,200	177,900
3	35,900	186,600
4	37,600	195,700
5 1/	39,500	205,200

1/ Obtained from WSCC-intervening years by interpolation.

Resources used in the FPC study of a 2,250 MW powerplant are from the WSCC report, "Summary of Estimated Loads and Resources," dated April 1976, updated to include all generating units placed in service in 1976, under construction, and planned. Additional information was obtained from individual utilities, as needed.

The FPC study showed that August is the probable month of peak demand and also the critical supply month under adverse hydro conditions. Reserve allowances of 20 percent of peak demand and 5 percent of energy needs were added to the requirements in order to represent the total loads to be met by the available supply in the critical month of August.

The FPC comparison of estimated loads and resources for 1993 showed a need for additional system peaking capability. The FPC concluded that the Marysville Lake project with an 1,800 MW peaking capability could dependably supply a portion of the study area's peaking requirements in 1993 and that a 2,250 MW installation could dependably supply a portion of the requirements in 1994.

8. <u>Water operation studies</u>. -

a. <u>General</u>. - Optimum powerplant size for various plans was determined by cooperative studies by the USBR and the Corps of Engineers. The USBR conducted water and power operation studies (based on monthly data), evaluated power benefits based on the latest available FPC values, estimated transmission costs (transmission lines and remote terminal

facilities), and performed alternative cost analysis and incremental analysis studies. The Corps of Engineers provided separable power costs (related structure costs, powerplant, and switchyard) and flood control requirements.

b. Period studied and flows. - The hydrologic study period used in the simulated operation studies covered the period 1895-1971.

(1) Fully impaired flows. - Operation studies were conducted using full natural flows, less impairments for inflow to Marysville Lake. Impairments are streamflow depletions which can legally be made by the present or future exercise of some type of existing water rights. Studies for the Marysville Lake project relied heavily on earlier studies of "full natural" and "impaired" flows made by International Engineering Company, Inc. (IECO) for the New Bullards Bar project.(4)(5)(6)(7)

For the period 1921-67, the values of inflow to Marysville Lake were taken from the 1969 IECO report, "Post Construction Reservoir Operation and Power Study." The values are listed in that report as "total inflow downstream."

For the period 1895-1903, the USBR arrived at inflow values by obtaining a similar year from an index for Sacramento basin inflow to the Delta. This index is based on the percent of normal (60-year average) derived from the Sacramento basin natural runoff as contained in DWR report "Drought Probability Study, Sacramento Basin," June 1973.

As an example, the Sacramento basin natural runoff in 1895 was 163 percent of normal and for the year 1941, the runoff was 158 percent of normal. Therefore, the inflow to Marysville in 1941 was duplicated for 1895.

For the period 1903-21 and 1967-72, the inflow values were taken from a correlation curve based on historical flow of Yuba River near Smartville versus the inflow to Marysville as listed in the IECO report since historical flow records at Smartville extend back to 1903. Once the annual values were obtained by this method, they were reduced to monthly values by adjusting the monthly values of similar years to total the annual values obtained from the correlation curve.

Operation studies based on fully impaired flows simulate the most conservative conditions (minimum flows) and were used for estimating potential irrigation water supply yield from the selected Marysville Lake project and alternatives.

(2) Partially impaired flows. - As discussed in Appendix F, Hydrology, Hydraulics, and Reservoir Regulation, studies indicate that existing water rights upstream of Marysville Lake are not fully utilized in the months of October through May and that the degree (percent) of utilization is related to annual precipitation. Studies also indicated that, on the average, basin runoff would be increased 173,000 acre-feet over computed runoff with impairments fully utilized, ranging from 71,000 acre-feet in a dry year to 271,000 acre-feet in a wet year.

Studies were made of hypothetical streamflows in the Yuba River at the mouth, with and without the Marysville Lake project, based on irrigation withdrawals and seepage losses downstream of the Marysville Lake project and on data generated from an operation study for the New Bullards Bar project (IECO, 1961). Data generated by the IECO studies do not reflect historical streamflows, but flows that would occur with full impairments (some of which have not been completely utilized in the past) as well as variations in annual basin runoff caused by changes in storage in New Bullards Bar Reservoir. Although there is presently more diversion from the river in the summer than in the past, the historical flows are substantially larger than impaired flows. In general, a greater degree of impairments is utilized during "dry" years than "normal" or "wet" years due to water availability.

A comparison was made between full natural flows, as shown in the IECO report, and historical flows for the period 1904-1967 in the Yuba River below Deer and Dry Creeks. A difference was noted in the relationship between impaired flows and historical flows before and after 1955, probably reflecting additional water depletions after 1955. The data indicated that, in extremely dry years, depletions in the summer approach or exceed entitlements and that an increasingly smaller percentage of impairments is utilized as annual runoff increases.

For the years 1955-1967, a study was made by months of the difference between published flow data and IECO computed impaired flows to determine average current (post 1955) use of impairments. Curves were developed for each month to determine the relationship between impairments not utilized and monthly basin runoff and to develop correction factors to be applied to fully impaired flows for the 1895-1971 period to develop partially impaired flows which reflect current and probable future use of impairments. It was determined that impairments are fully utilized in June through September and that an average correction can be used in all years in October, November, and December. The additions to full impairments to reflect current use are shown by years (1895 through 1971) for the months of January through May in Appendix F. On the average, basin runoff was increased 173,000 acre-feet, or an average of about 10 percent, by considering partial impairments. The correction in any given year ranged between 71,000 acre-feet for a dry year and 271,000 acre-feet for a wet year, as shown in Appendix F.

It is probable that in the August-May period this additional streamflow will continue to pass downstream through the Marysville Lake project.

Accordingly, operation studies for evaluating the power benefits were based on partially impaired flows.

c. Critical dry period. - The most severe series of years during the study period, with regard to basin runoff, is the 1928 to 1934 period, referred to as the "critical dry period." This period includes 3 normal years (1928-30) and 4 critical years (1931-34).

At the beginning of a critical dry period, such as began in April 1928, the USBR assumed that all the main storage reservoirs in the Central Valley Project would be full. At the end of September of the first of those dry years, enough water would be held in storage to ensure the development of the firm yield and dependable capacity in the remaining dry years. The reservoirs are integrally operated so that, by the end of the critical dry period in December 1934, nearly all of the carryover storage would be used.

d. Operation study criteria. -

(1) Evaporation. - A net evaporation loss of 3.0 feet per year was used, based on USBR evaporation data for Folsom and Auburn Reservoirs. Evaporation rates were estimated from pan evaporation records at Pardee Reservoir. This 7-year record, January 1928 through December 1934, was reduced to lake evaporation by applying a pan factor of .77 based on data in Bulletin No. 54, "Evaporation from Water Surfaces in California,"

published by the California State Department of Water Resources in 1947. The lake evaporation was reduced by the monthly amount of precipitation recorded at the Folsom precipitation station. The monthly net evaporation for the 7-year period was then averaged. The 3.0 feet per year net evaporation rate was distributed as follows:

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0.3	0.0	-0.3	-0.2	-0.1	0.0	0.2	0.5	0.6	0.8	0.7	0.5

(2) Water rights and seepage. - Monthly releases from the Marysville Lake project include flows required to meet pre-New Bullards Bar downstream diversion rights and requirements. These releases total 135,200 acre-feet annually for prior rights and 25,000 acre-feet annually for seepage losses, with the monthly pattern as shown on page III-4 of the IECO Post Construction and Power Study.

(3) Yuba County Water Agency diversions. - Monthly releases include flows required to meet YCWA rights below Narrows, as shown on page III-4 of the IECO report. Total for a normal year is 172,100 acre-feet, with reductions during years of subnormal streamflow from June through October, as follows:

Forecast Streamflow Percent of Normal	Percent Reduction in Normal New Releases
Above 85	0
51 - 85	15
50 or less	30

Data for the streamflow forecasts to determine deficient years are from page III-8 of the IECO report covering the years 1922-67. The streamflow forecasts for the period outside this range was arrived at by finding a similar year as described in subparagraph 8B.

(4) CVP releases. - In studies to determine maximum economical minimum pool, releases were made to provide supplemental water for CVP diversion in the Delta. The months of release were distributed on a pattern using the Mid-Valley demand pattern.

(5) Fish releases. - For basic studies, minimum fish release requirements at the mouth of Yuba River, as coordinated with the U.S. Fish and Wildlife Service and California Department of Fish and Game, are 800 cfs October through January and in May, 600 cfs June through September and 1,000 cfs in February, March, and April. Deficiencies were taken as listed on page III-3 of the IECO report.

(6) Flow-through water. - Releases were made for this purpose as required, so that at least reservoir inflow would be released when there is no unappropriated water in the Delta.

(7) Maximum allowable end-of-month storage. - Storage limits were based on Corps of Engineers criteria to provide the required flood control space during the winter flood season.

(8) Water available in Delta for CVP. - This is equal to the total of all reservoir releases, described in subparagraphs 8d(2)-(6), less the inflow to Marysville Lake.

(9) Releases for power. - No downstream releases were made specifically for power. Rather reservoir releases for other project purposes, determined by the USBR in earlier operation studies for irrigation yield, were routed through the afterbay powerplant to the extent feasible in the power studies. Releases were made for power only at the main powerplant, but flows in excess of downstream requirements were pumped from the afterbay back to the lake during offpeak hours.

9. Power studies. -

a. Criteria. -

(1) Dependable capacity. - Dependable capacity is based on plant capability for each month of the critical dry cycle from May 1930 through December 1933. The reservoir level on 1 May 1930 was assumed to be at maximum storage allowed for flood control. The dependable capacity developed during the critical dry cycle was at a 10 percent annual capacity factor; however, the annual capacity factor, based on average annual generation, is greater than 10 percent. In determining power benefits for dependable capacity, the 10 percent annual capacity factor value for capacity was used.

(2) Energy. - The hydroplant capacity available is considered dependable and marketable at a 10 percent annual capacity factor, and must be supported with energy during the critical dry-cycle equal to 876 kWh per kW annually. The kWh per kW used in the studies for each month are as follows:

Month	kWh/kW	Month	kWh/kW
Jan	55	Aug	122
Feb	55	Sep	103
Mar	55	Oct	72
Apr	55	Nov	55
May	55	Dec	55
Jun	72		
Jul	122	Total	876

In determining power benefits for energy, for the amount of energy equal to 876 kWh per kW of dependable capacity, the 10-percent annual capacity factor values for energy was used, and for the amount of energy in excess of 876 kWh per kW, the energy value associated with the average annual capacity factor derived based on the total average annual generation and the dependable capacity was used.

b. Pumping energy. - For plans with pump-turbine installations, energy is required to pump back into the main reservoir that amount of water, in excess of normal mandatory releases, that must be released to generate the minimum energy required to support dependable capacity at the assumed 10 percent annual capacity factor. Recognizing that the dependable capacity is determined during a critical dry water supply period, the combination of conventional and pumping-generating units affects power accomplishments as follows:

- Dependable capacity is increased to the plant's capability limit, and average annual generation is also increased.

- The average annual pumping energy is considerably less than the amount required during the critical dry cycle to firm up the dependable capacity because in years with average or better water conditions, normal water releases are almost enough to generate the minimum energy required to support dependable capacity; and, therefore, very little pumping is required.

A pump-storage operation requires about 3 kWh of energy to pump an amount of water back into storage to generate each 2 kWh when the same amount of water is released from storage. The major benefit of pump-storage is the ability to use low value offpeak energy for pumping and to generate onpeak when the need for and value of energy is greater. The FPC estimates that the probable source for this low-value offpeak energy after 1993 would be nuclear-fired generating plants and estimates the cost of such energy at 3.24 mills/kWh, based on 1 January 1976 price levels. Studies were made to determine the optimum size pump-turbine installation using the 3.24 mills value furnished by the FPC, and a sensitivity analysis also was made using an offpeak pumping cost of 10 and 17.18 mills/kWh to determine the effect of pumping costs on plant size.

c. Minimum pool. -

(1) Selected plan. - The tradeoff in benefits between irrigation yield and power with changes in minimum (inactive) pool was evaluated early in the studies using data from studies with a 900 MW powerplant (based on FPC January 1975 values for power and a value of $44.55 per acre-foot for irrigation yield) for a range of minimum pools from 50,000 acre-feet and 280,000 acre-feet. The data were reevaluated for a 2,250 MW powerplant and using $67.08 per acre-feet for irrigation yield as shown in Figure I-8 for a range of minimum pool sizes. These data confirm the earlier analysis and show that, within the range studied, power benefits increase at a faster rate than irrigation benefits decrease, indicating that total excess benefits for power and irrigation increase with increase in minimum pool.

Operation studies indicate the maximum feasible minimum pool, when releases are made to meet all mandatory downstream requirements and to provide flows for fish (600/800/1,000 cfs) desired by fish and wildlife agencies, is 367,000 acre-feet with partially impaired flows. On the basis of this analysis a minimum pool of 367,000 acre-feet was used in subsequent power studies for the selected plan.

(2) NED plan. - For the NED plan the 2,250 MW pumped storage powerplant would be installed initially. Releases would be made to meet mandatory downstream requirements and to provide flows for fish desired by fish and wildlife agencies (600/800/1,000 cfs). The optimum minimum pool for the NED plan is the same as for the selected plan, 367,000 acre-feet.

(3) EQ plan. - The EQ plan has 514,000 acre-feet of reservoir storage at gross pool elevation, compared to 916,000 acre-feet for the selected plan. This storage for the EQ plan is not adequate to provide flows for fish of 600/800/1,000 cfs in all years; however, these flows could be provided in all except dry years when presently required flows of 70/250/400 cfs would be guaranteed. These fish flows limit the maximum minimum pool; however, for the EQ plan, provision of flows for fish was given higher priority than developing monetary power benefits. Under these conditions, the minimum pool is 83,000 acre-feet.

10. Power evaluation - main dam peaking powerplants. -

The USBR conducted studies of power accomplishments, which consist of average annual generation and dependable capacity for conventional plants. For pumped storage plants, a third component, average annual pumping, must also be considered. The average annual generation data were based on operation studies covering 77 years of hydrological record (1895 through 1971) and reflect the average energy that would have been generated had the project been in operation. Power accomplishments presented in this appendix are at the load center (L.C.), and transmission costs are included in separable power costs.

The annual equivalent power benefits and alternative costs, were determined based on: (1) power values furnished by the Federal Power Commission (FPC) by letter dated 16 July 1976, included in Appendix B;

and (2) a 100-year period of analysis with a 3-1/4 percent interest rate and 6-1/8 percent (latest available from FPC) interest rate. Power benefits and alternative costs are determined based on average annual generation and dependable capacity; the dependable capacity is developed during the critical dry-cycle at a 10 percent annual capacity factor. FPC power values were used to determine power benefits and alternative costs, as follows.

- Dependable capacity--the 10 percent annual capacity factor value for capacity was used.

- Average annual generation--(1) for the amount of energy equal to 876 kilowatt-hours per kilowatt of dependable capacity, the 10-percent annual capacity factor values for energy was used; and (2) for the amount of energy in excess of 876 kilowatt-hours per kilowatt, the energy value associated with the average annual capacity factor derived based on the total average annual generation and the dependable capacity was used.

Construction cost estimates for the powerplant and switchyard were prepared by the Corps of Engineers, and construction cost estimates for transmission facilities (transmission lines and remote terminal facilities) were prepared by the Bureau of Reclamation.

Since the dependable capacity of a conventional hydroplant is determined during a critical dry water supply period, power accomplishments can be increased by adding pumping-generating units.

The average annual pumping energy for pumped storage developments was determined for the 77 years of hydrological record (1895 through 1971), based on the energy that is required to pump back into the main reservoir that amount of water--in excess of normal mandatory releases--that must be made to generate the minimum energy required to support dependable capacity at the assumed 10 percent annual capacity factor. Recognizing that the dependable capacity is determined during a critical dry water supply period, the combination of conventional and pumping-generation units impacts the power accomplishments as follows:

- Dependable capacity is increased to the plant's capability limit.

- The average annual pumping is considerably less than the amount required to firm up the dependable capacity because in years with average or better water conditions, normal water releases are almost enough to generate the minimum energy required to support dependable capacity and, therefore, very little pumping is required.

a. <u>Selected plan</u>. - Power accomplishments were evaluated by the USBR for a range of pumped storage plants, based on the installation

of one 450 MW conventional turbine and 450 MW pump-turbines. The maximum size plant studied was 2,250 MW which is the maximum size installation that can be sited into the canyon with reasonable excavation. The operation study which served as the basis for the power analysis was based on providing minimum downstream flows for fish of 600/800/ 1,000 cfs and partial impairments of upstream water rights, as discussed in Appendix F, Hydrology, Hydraulics, and Reservoir Operation. Power accomplishments and power benefits, alternative costs, and project costs at load center are shown in the following tabulations.

Power Accomplishments

Plant Size MW	Average Generation @ L.C. GWh	Average Pumping @ L.C. GWh	Dependable Capacity @ L.C., @ 10% A.C.F. MW
900	810	470	810
1350	1120	1000	1260
1800	1420	1500	1660
2250	1720	2000	2030

Power benefits and alternative costs 2/

Powerplant Size MW	Annual Equivalent 1/ Power Benefit $1,000 3-1/4%	Power Benefit $1,000 6-1/8%	Alternative Cost $1,000 3-1/4%	Alternative Cost $1,000 6-1/8%
900	42,900	41,500	29,300	31,400
1350	63,400	61,200	45,400	48,500
1800	81,900	79,100	58,200	62,300
2250	99,700	96,200	70,600	75,700

1/ January 1976 Price Level.
2/ At load center.

Summary of Cost Estimates
(January 1976 Price Level)

Plant Size MW	Powerplant and Switchyard $1,000	Transmission Facilities $1,000	Pumping Costs	Total Cost 1/ $1,000
		First Cost		
900	328,000	51,000		379,000
1350	410,000	77,000		487,000
1800	485,000	79,000		564,000
2250	558,000	82,000		640,000
		Annual Cost @ 3-1/4% Interest 3.24 mills/kWh pumping cost		
			Pumping Costs	Total
900	14,600	2,800	1,400	18,800
1350	18,500	3,700	3,100	25,300
1800	22,000	4,000	4,600	30,600
2250	25,600	4,200	6,100	35,900
		Annual Cost @ 6-1/8% Interest 3.24 mills/kWh pumping cost		
900	27,000	4,500	1,400	32,900
1350	34,000	5,700	3,000	42,700
1800	40,300	6,100	4,400	50,800
2250	46,700	6,300	5,900	58,900

1/ At load center.

A benefit-cost analysis for the range of plant sizes studied is presented in the next tabulation. The data indicate that the increments are all feasible at both 3-1/4 and 6-1/8 percent interest.

Benefit-Cost Analysis 1/
3.24 mills/kWh pumping cost
(Composite Financing)

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis Costs $1,000	Incremental Analysis Benefits $1,000	Incremental Analysis B/C Ratio
		3-1/4 percent interest				
900	18,800	42,900	24,100			
				6,500	20,500	3.15
1350	25,300	63,400	38,100			
				5,300	18,500	3.49
1800	30,600	81,900	51,300			
				5,300	17,800	3.36
2250	35,900	99,700	63,800			
		6-1/8 percent interest				
900	32,900	41,500	8,600			
				9,800	19,700	2.01
1350	42,700	61,200	18,500			
				8,100	17,900	2.21
1800	50,800	79,100	28,300			
				8,100	17,100	2.11
2250	58,900	96,200	37,300			

1/ January 1976 price levels; at load center.

In years when pumping is required, the average annual generation is also increased. However, it should be noted that a pumped-storage operation requires more energy to pump an amount of water back into storage than is generated when the same amount of water is released from storage. The major benefit of pump-storage is the ability to

use low value offpeak energy for pumping and generating onpeak when the need for and value of energy is greater. The FPC indicates that after 1993 the source for this low value offpeak energy is expected to be from nuclear-fired generating plants. The FPC estimates the energy rate to be 3.24 mills/kWh. A sensitivity analysis was run using 10 and 17.18 mills/kWh, and the costs and benefit-cost analysis are shown in the next tabulations.

Pumping Cost Analysis

Plant Size MW	Pump Energy GWh	Pumping Costs (average annual) ($1,000) 3.24 mills/kWh	10.0 mills/kWh	17.18 mills/kWh
3-1/4 percent interest				
900	470	1,400	4,400	7,600
1,350	1,000	3,100	9,500	16,300
1,800	1,500	4,600	14,200	24,500
2,250	2,000	6,100	18,900	32,500
6-1/8 percent interest				
900	470	1,400	4,300	7,300
1,350	1,000	2,900	9,100	15,600
1,800	1,500	4,400	13,700	23,500
2,250	2,000	5,900	18,200	31,200

Benefit-Cost Analysis 1/

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis: Costs	Incremental Analysis: Benefits	Incremental Analysis: B/C Ratio
Pumping Cost 10.0 mills/kWh - 3-1/4 Percent Interest						
900	21,800	42,900	21,100			
				9,900	20,500	2.1
1,350	31,700	63,400	31,700			
				8,500	18,500	2.2
1,800	40,200	81,900	41,700			
				8,500	17,800	2.1
2,250	48,700	99,700	51,000			
Pumping Cost 17.18 mills/kWh - 3-1/4 Percent Interest						
900	25,000	42,900	17,900			
				13,500	20,500	1.5
1,350	38,500	63,400	24,900			
				12,000	18,500	1.5
1,800	50,500	81,900	31,400			
				11,100	17,800	1.6
2,250	62,300	99,700	37,400			
Pumping Cost 10.0 mills/kWh - 6-1/8 Percent Interest						
900	35,800	41,500	5,700			
				13,100	19,700	1.5
1,350	48,900	61,200	12,300			
				11,200	17,900	1.6
1,800	60,100	79,100	19,000			
				11,100	17,100	1.5
2.250	71,200	96,200	25,000			
Pumping Cost 17.18 mills/kWh - 6-1/8 Percent Interest						
900	38,800	41,500	2,700			
				16,600	19,700	1.2
1,350	55,400	61,200	5,800			
				14,500	17,900	1.2
1,800	69,900	79,100	9,200			
				14,300	17,100	1.2
2,250	84,200	96,200	12,000			

1/ At load center.

The foregoing data indicate that power installations up to 2,250 MW are feasible at the range of pumping costs studied. The effect of pumping costs on the overall project B/C ratio is presented in Appendix K, Socio-Economic Analysis.

Hydroplant costs for a range of installation sizes are compared to alternative project costs in the next tabulation using a pumping cost of 3.24 mills/kWh. The data indicate that all plants meet the comparability test at both interest rates except the 900 MW plant at 6-1/8 percent. At 3-1/4 percent and using 10.0 and 17.18 mills/kWh for pumping all plants meet the comparability test. However, at 6-1/8 percent, the plants would meet the comparability tests using limiting pumping costs as follows:

Plant	Pumping cost (mills/kWh)
1,350 MW	6.04
1,800 MW	7.97
2,250 MW	8.69

Alternative Costs Analysis
Comparability Test 1/

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Alternative Costs $1,000	Excess Alternative Costs $1,000
	3-1/4 percent interest		
900	18,800	29,300	10,500
1350	25,300	45,400	20,100
1800	30,600	58,200	27,600
2250	35,900	70,600	34,700
	6-1/8 percent interest		
900	32,900	31,400	-1,500
1350	42,700	48,500	5,800
1800	50,800	62,300	11,500
2250	58,900	75,700	16,800

1/ At load center.

b. NED plan. - Studies were made of the 2,250 MW pumped-storage powerplant installed initially at the Parks Bar site with impoundment on both the Yuba River and Dry Creek, with downstream minimum flows for fish desired by fish and wildlife agencies (600,800,1,000 cfs). Accomplishments and related data are as follows.

Power accomplishments

Average annual generation at L.C., 1,720 GWh

Average annual pumping at L.C., 2,000 GWh

Dependable capacity at L.C. @ 10% A.C.F., 2,030 MW

Power benefits, average annual equivalent (January 1976 price level)

Benefits @ 3-1/4 percent, $99,700,000 at L.C.

Benefits @ 6-1/8 percent, $96,200,000 at L.C.

Annual Costs (January 1976 price level)

	3-1/4 Percent	6-1/8 Percent
Powerplant	$29,800,000	$53,000,000
Pumping (at 3.24 mills/kWh)	6,100,000	5,900,000
Total	$35,900,000	$58,900,000

Comparability Test

	3-1/4 Percent	6-1/8 Percent
Total annual costs	$35,900,000	$58,900,000
Annual alternative costs	70,600,000	75,700,000
Excess alternative costs	34,700,000	16,800,000

c. Conventional powerplants. - Power accomplishments were evaluated by the USBR for a range of sizes of conventional powerplants, based on the installation of two conventional turbine units for each size of powerplant. The operation study which served as the basis for the power analysis was based on providing minimum downstream flows for fish of 600/800/1,000 cfs and partial impairments of upstream water rights. Power accomplishments and benefits and costs for conventional powerplants at the Marysville Lake project are given in the following tabulations.

Power accomplishments

Plant Size MW	Average Generation @ L.C. GWh	Dependable Capacity @ L.C., @ 10% A.C.F. MW
200	515	190
300	526	236
400	527	247

Summary of Cost Estimates
(January 1976 Price Level)

Plant Size MW	Powerplant and Switchyard $1,000		Transmission Facilities $1,000		Total Cost $1,000	
			First Cost			
200	218,000		16,000		244,000	
300	238,000		21,000		259,000	
400	260,000		26,000		286,000	
			Annual Cost			
	3-1/4%	6-1/8%	3-1/4%	6-1/8%	3-1/4%	6-1/8%
200	9,200	17,500	800	1,200	10,000	18,700
300	10,100	19,200	1,000	1,500	11,100	20,700
400	11,100	21,000	1,300	1,900	12,400	22,900

Benefit-Cost Analysis 1/
(Composite financing)

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis Costs $1,000	Incremental Analysis Benefits $1,000	Incremental Analysis B/C Ratio
		3-1/4 percent interest				
200	10,000	10,600	600			
				1,100	2,300	2.1
300	11,100	12,900	1,800			
				1,300	700	0.5
400	12,400	13,600	1,200			
		6-1/8 percent interest				
200	18,700	10,300	-8,400			
				-	-	-
300	20,700	12,600	-8,100			
				-	-	-
400	22,900	13,400	-9,500			

1/ January 1976 price levels.

The foregoing benefit-cost analysis indicates that a 300 MW plant is the optimum conventional hydroplant size at a 3-1/4 percent interest rate. None of the conventional plant sizes investigated was feasible at 6-1/8 percent interest rate.

The following tabulations indicate that none of the conventional powerplants meet the comparability test at 3-1/4 percent or 6-1/8 percent interest rates and that the best plan at 3-1/4 percent is the 300 MW installation.

Alternative Costs Analysis
Comparability Test

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Alternative Costs $1,000	Excess Alternative Costs $1,000
	3-1/4 percent interest		
200	10,000	7,900	-2,100
300	11,100	9,400	-1,700
400	12,400	9,800	-2,600
	6-1/8 percent interest		
200	18,700	8,300	-10,400
300	20,700	10,000	-10,700
400	22,900	10,400	-12,500

d. EQ plan. - Studies were made to determine the optimum powerplant for the EQ plan at the Parks Bar site, with impoundment on only the Yuba River. Minimum downstream flows for fish were 600/800/1,000 cfs in all

except dry years. These studies indicated that the only plant that was feasible was the 100 MW plant at 3-1/4 percent interest. No plant met the comparability test at either 3-1/4 or 6-1/8 percent.

Accomplishments and related data for this plan are as follows.

Plant Size MW	Power Accomplishments: Average Generation @ L.C. GWh	Power Accomplishments: Dependable Capacity @ L.C. MW
75	350	45
100	380	60
150	410	65

Benefit-Cost Analysis
(Composite Financing)

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis: Costs $1,000	Incremental Analysis: Benefits $1,000	Incremental Analysis: B/C Ratio
		3-1/4 percent interest				
75	3,400	3,200	-200			
				300	700	2.3
100	3,700	3,900	200			
				-	-	-
150	4,300	4,200	-100			
		6-1/8 percent interest				
75	6,100	3,100	-3,000			
				-	-	-
100	6,600	3,800	-2,800			
				-	-	-
150	7,600	4,100	-3,500			

Alternative Costs Analysis
Comparability Test

Plant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Alternative Costs $1,000	Excess Alternative Costs $1,000
	3-1/4 percent interest		
75	3,400	2,500	-900
100	3,700	3,100	-600
150	4,300	3,300	-1,000
	6-1/8 percent interest		
75	6,100	2,600	-3,500
100	6,600	3,200	-3,400
150	7,600	3,400	-4,200

11. Power evaluation - afterbay dam baseload powerplants. -

a. Selected plan and NED plan. - Power accomplishments were evaluated by the USBR for a range of sizes of baseload powerplants at the afterbay dam, based on the installation of two conventional turbine units for each size of powerplant. Dependable capacity for afterbay powerplants is assumed to be the average megawatts available at 60 percent annual capacity factor, based on water year 1931. Power accomplishments, benefits, and costs are given in the following tabulations.

Power Accomplishments

Main Plant Size MW	Afterbay Powerplant Size MW	Average Generation @ L.C. GWh	Dependable Capacity @ L.C., @ 60% A.C.F. MW
	10	78	9.5
1,350	15	98	14.3
	20	109	14.3
	25	117	14.3
	10	80	9.5
1,800	15	104	14.3
	20	118	15.2
	25	127	15.2
	10	81	9.5
2,250	15	108	14.3
	20	125	17.1
	25	136	17.1

Summary of Cost Estimate
(January 1976 price level)

Main Plant Size MW	Afterbay Powerplant Size MW	First Cost: Powerplant and Switchyard $1,000	First Cost: Transmission Facilities[1/] $1,000	First Cost: Total $1,000	Annual Cost: Powerplant and Switchyard $1,000 3-1/4%	Annual Cost: Powerplant and Switchyard $1,000 6-1/8%	Annual Cost: Transmission Facilities $1,000 3-1/4%	Annual Cost: Transmission Facilities $1,000 6-1/8%	Annual Cost: Total $1,000 3-1/4%	Annual Cost: Total $1,000 6-1/8%
	10	12,300	700	13,000	610	1,070	30	60	640	1,130
1350	15	14,000	700	14,700	710	1,230	30	60	740	1,290
	20	15,200	900	16,100	790	1,360	40	70	830	1,430
	25	17,300	1,000	18,300	900	1,550				
	10	12,400	700	13,100	620	1,090	30	50	650	1,140
1800	15	14,000	700	14,700	710	1,230	30	60	740	1,290
	20	15,400	900	16,300	800	1,380	40	60	840	1,440
	25	17,100	1,000	18,100	890	1,530	40		930	
	10	13,300	700	14,000	650	1,150	30	50	680	1,200
2250	15	14,100	700	14,000	710	1,240	40	60	750	1,300
	20	15,400	900	16,300	790	1,370	50	70	840	1,440
	25	17,400	1,000	18,400	890	1,550	50	70	940	1,620

1/ Based on afterbay plants tied to main powerplant switchyard.

Benefit-Cost Analysis 1/
(Composite financing)

Main Plant Size MW	Afterbay Powerplant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis Costs $1,000	Incremental Analysis Benefits $1,000	Incremental Analysis B/C Ratio
			3-1/4 percent interest				
1350	10	640	1,200	560			
	15	740	1,740	1,000	100	540	5.4
	20	830	1,770	940	90	30	0.3
1800	10	650	1,200	550			
	15	740	1,750	1,010	90	550	6.1
	20	840	1,890	1,050	100	140	1.4
	25	930	1,920	990	90	30	0.3
2250	10	680	1,210	530			
	15	750	1,770	1,020	70	560	8.0
	20	840	2,110	1,270	90	340	3.8
	25	940	2,140	1,200	100	30	0.3

1/ October 1976 price levels.

Benefit-Cost Analysis (Cont'd)

Main Plant Size MW	Afterbay Powerplant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Power Benefits $1,000	Excess Power Benefits $1,000	Incremental Analysis Costs $1,000	Incremental Analysis Benefits $1,000	Incremental Analysis B/C Ratio
			6-1/8 percent interest				
1350	10	1,130	1,200	70			
	15	1,290	1,740	450	160	540	3.4
	20	1,430	1,770	340	140	30	0.2
1800	10	1,140	1,200	60			
	15	1,290	1,750	460	150	550	3.7
	20	1,440	1,890	450	150	140	0.9
2250	10	1,200	1,210	10			
	15	1,300	1,770	470	100	560	5.6
	20	1,440	2,110	670	140	340	2.4
	25	1,620	2,140	520	180	30	0.2

The foregoing benefit-cost analysis indicates that a 15 MW plant is the optimum conventional hydroplant size for the selected plan and the NED plan.

The comparability test, shown in the next tabulation, indicates the Federal construction cost of a 15 MW installation is less than the alternative costs of a Federally financed steamplant at 3-1/4 percent, but the plant does not meet comparability at 6-1/8 percent. However, in view of the need for energy and the resource available, a 15 MW plant at the afterbay is included in the selected plan.

Alternative Costs Analysis
Comparability Test

Main Plant Size MW	Afterbay Powerplant Size MW	Annual Hydroplant Costs $1,000	Annual Equivalent Alternative Costs $1,000	Excess Alternative Costs $1,000
		3-1/4 percent interest		
1350	10	640	660	20
	15	740	940	200
	20	830	970	140
1800	10	650	670	20
	15	740	950	210
	20	840	1,040	200
	25	930	1,070	140
2250	10	680	670	-10
	15	750	970	220
	20	840	1,150	310
	25	940	1,180	240
		6-1/8 percent interest		
1350	10	1,130	810	-320
	15	1,290	1,150	-140
	20	1,430	1,190	-240
1800	10	1,140	810	-330
	15	1,290	1,170	-120
	20	1,440	1,270	-170
2250	10	1,200	820	-380
	15	1,300	1,190	-110
	20	1,440	1,410	-30
	25	1,620	1,440	-180

b. Conventional main dam powerplant. - Studies for the conventional main dam powerplant plan indicated the optimum afterbay powerplant size is 15 MW. Accomplishments and related data are as follows.

Power accomplishments

Average generation at L.C.,	60 GWh
Dependable capacity at L.C. @ 60% A.C.F.,	9 MW

Power benefits, average annual equivalent (January 1976 price level)

Benefits @ 3-1/4 percent, $1,030,000 at L.C.

Benefits @ 6-1/8 percent, $1,030,000 at L.C.

Annual costs (January 1976 price level)

	3-1/4 Percent	6-1/8 Percent
Powerplant	$740,000	$1,280,000

Comparability test

	3-1/4 Percent	6-1/8 Percent
Total annual costs	$740,000	$1,280,000
Annual alternative costs	$550,000	$ 680,000
Excess alternative costs	-$190,000	-$ 600,000

c. EQ plan. - Studies for the EQ plan indicated the optimum afterbay powerplant size is 10 MW. Accomplishments and related data are as follows.

Power accomplishments

Average generation at L.C.,	60 GWh
Dependable capacity at L.C. @ 60% A.C.F.,	9 MW

Power benefits, average annual equivalent (January 1976 price level)

Benefits @ 3-1/4 percent, $1,040,000 at L.C.

Benefits @ 6-1/8 percent, $1,040,000 at L.C.

Annual costs (January 1976 price level)

	3-1/4 Percent	6-1/8 Percent
Powerplant	$ 630,000	$1,090,000

Comparability test

	3-1/4 Percent	6-1/8 Percent
Total annual costs	$1,040,000	$1,040,000
Annual alternative costs	$ 560,000	$ 690,000
Excess alternative costs	-$ 480,000	-$ 350,000

12. <u>Power facilities for selected plan</u>. -

Two powerplants would be built as part of the selected plan: a 2,250 MW capacity powerplant with 1,350 MW installed initially would be constructed at the main Yuba River dam at Parks Bar site and a 15 MW capacity powerplant would be constructed at the afterbay dam at the lower Long Bar site.

The main dam powerhouse would have four bays, one standard unit bay and three pump-turbine bays, housing one 450 MW standard turbine, generator unit and two 450 MW pump-turbine, motor generator units. The empty pump-turbine bay would be used as an erection bay during initial installation. Ultimately an additional pump turbine bay and an erection bay would be constructed and two additional 450 MW pump-turbine, motor generator units installed. All turbines at the main dam powerhouse would be of the Francis, or radial flow, type. The pump-turbines would be reversible, rotating in one direction when operating as a turbine to generate power and rotating in the opposite direction to pump water from the afterbay to the lake. Pump-turbines would be started by electrically connecting them to the standard unit at standstill and accelerating the synchronized units to rated speed together.

The afterbay powerhouse would have three bays, two for adjustable blade vertical, propeller turbines of the Kaplan type driving a 7.5 MW generator and an erection bay. Turbines would be sized to produce generator overload capacity at design head with normal blade setting with the design head set as low as is feasible in order to increase power output at low heads.

Unit characteristics are shown in the following tabulation.

Power Unit Characteristics

Location Unit	Main Dam Powerplant Standard turbine generator	Main Dam Powerplant Pump-turbine motor-generator	Afterbay Powerplant Standard turbine generator
Generator rating, MW	450	450	7.5
Overload rating	1.15	1.15	1.15
kVA at unity power factor	544,700	544,700	9,080
Motor horsepower	-	679,800 (1)	-
Turbine type	Francis	Francis pump-turbine	Kaplan
Horsepower	708,000	632,000 (1)	11,800
Runner dia., inches	328	468/376	115
Max head, feet	367	367	111
Design head, feet	293.6	293.6	74
Min. head, feet	190.8	190.8	37

(1) Pump operation.

Power generated in the main dam powerhouse would be stepped up to 500 kV via transformers at the powerhouse for distribution into the power network. Distribution would be made from a 500 kV switchyard located near the powerhouse. A separate switchyard for the afterbay dam powerplant would step up the power from the 15 MW powerplant to 230 kV.

Power facilities are discussed in more detail in Appendix L, Basis of Design of Selected Plan.

APPENDIX I
REFERENCES CITED

(1) Federal Power Commission, Bureau of Power, Final Environmental Impact Statement, Helms Project No. 2735 - California, November 1975.

(2) Federal Power Commission, National Power Survey Advisory Committee Report: Energy Conservation, December 1974.

(3) Institute of Electrical and Electronics Engineers, New York, N.Y.

(4) International Engineering Company, Inc., Definitive Reservoir Operation and Power Study, March 1963.

(5) International Engineering Company, Inc., Post Contruction Reservoir Operation and Power Study, November 1969.

(6) International Engineering Company, Inc., Report on Development of Water Resources of Yuba River, January 1961.

(7) International Engineering Company, Inc., Supplement to Report on Development of Water Resources of Yuba River, June 1961.

(8) Resolution No. 9 at the Annual Convention of National Association of Regulatory Commissioners (NARUC), San Diego, California, 5 December 1974.

(9) State of California, Department of Water Resources, Hydroelectrical Energy Potential in California, Bulletin No. 194, March 1974.

(10) State of California Energy Resources Conservation and Development Commission, Staff Proposed Electricity Forecasting and Planning Report, October 1976.

(11) State of California, Public Utilities Commission, Report on Ten-year Forecasts of Electric Utilities Loads and Resources, October 1973.

(12) State of California, Resources Agency, Energy Dilemma, June 1973.

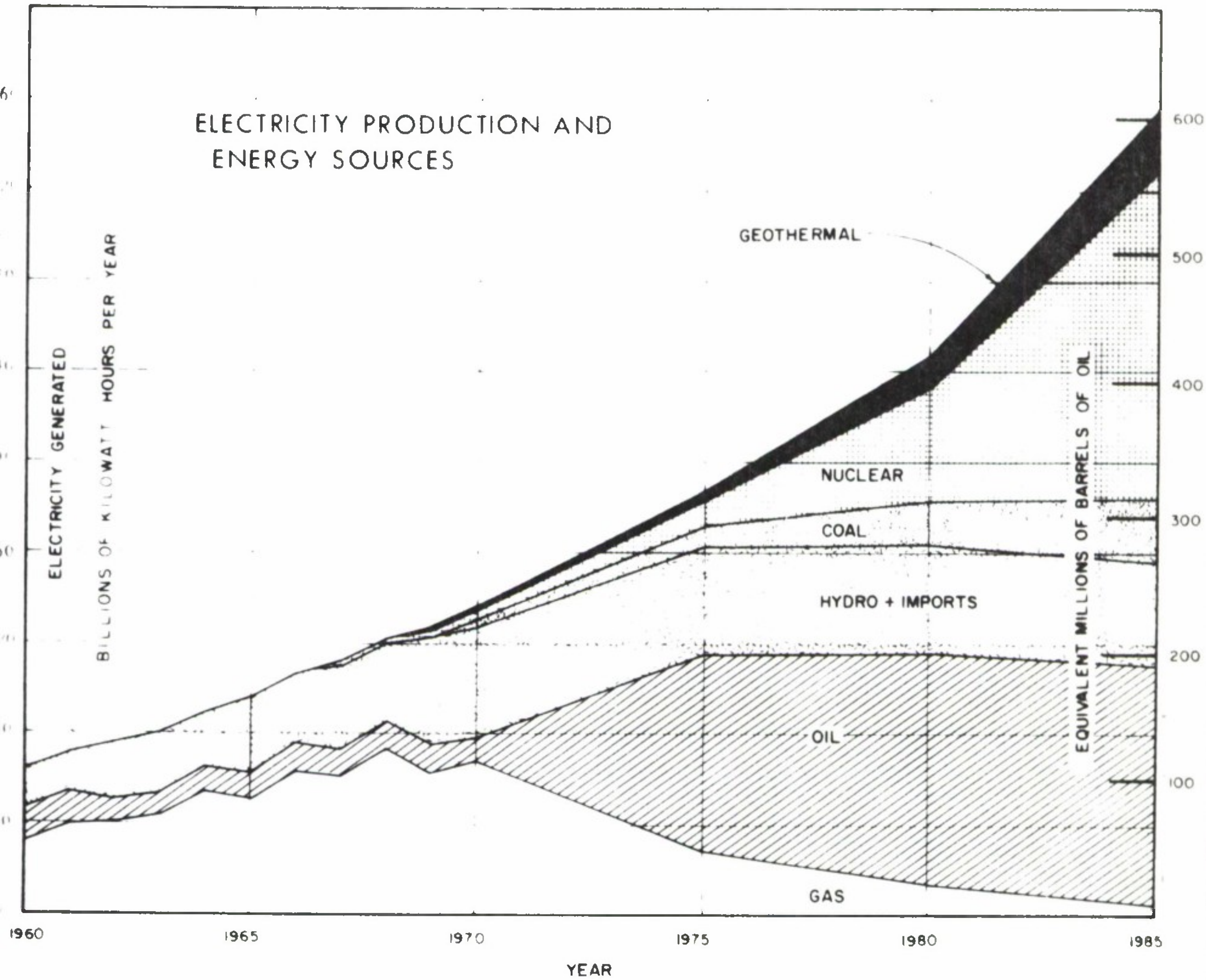
(13) Task Force on Energy of the National Academy of Engineering, U.S. Energy Prospects, An Engineering Viewpoint, 1974.

(14) Trumbower, S. A., A New Computerized Model Speeds Utility Land Management Strategy Development, 1 March 1976.

(15) U.S. Bureau of Census, Statistical Abstract of the United States: 1971.

(16) U.S. Department of the Interior, Walter G. Dupree, Jr. and James A. West, United States Energy Through the Year 2000, December 1972.

(17) Western Systems Coordinating Council, Ten-Year Coordinated Plan Summary, 1975-1984, May 1975.



Source. State of California
Department of Water Resources.
Bulletin No 194, HYDROELECTRIC
ENERGY POTENTIAL IN CALIFORNIA,
MARCH 1974

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

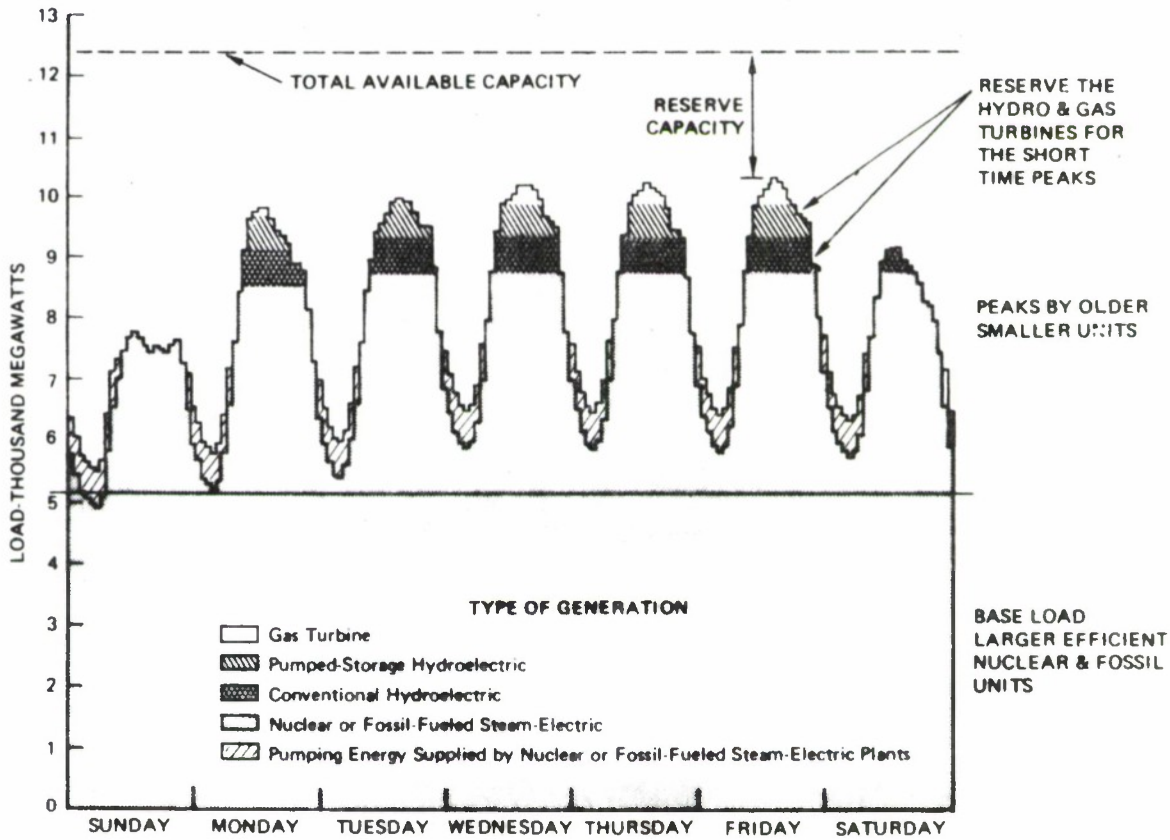
ELECTRICITY PRODUCTION AND
ENERGY SOURCES IN CALIFORNIA

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE I-I

U.S. TYPICAL WEEKLY ELECTRICITY DEMAND



SOURCE: National Academy of Engineering. "U.S. Energy Prospects: An Engineering Viewpoint." 1974.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

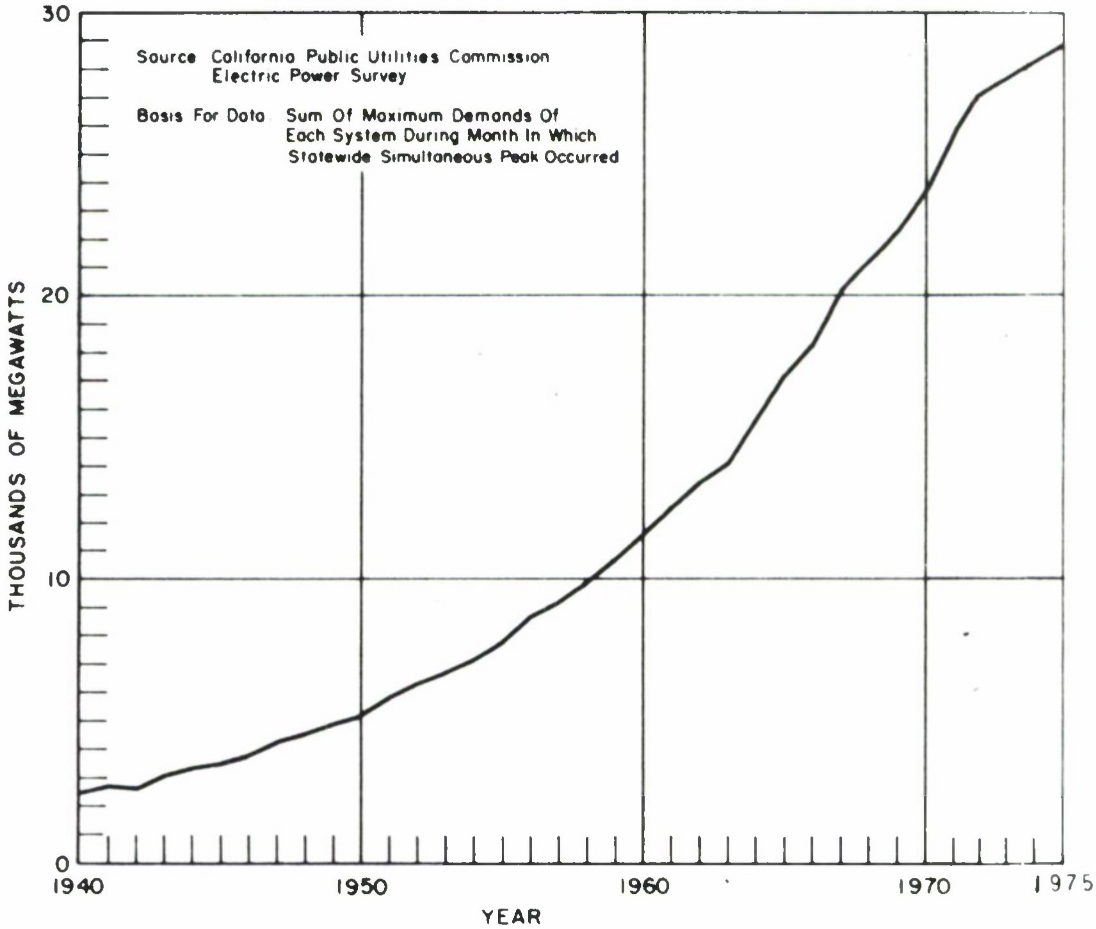
TYPICAL VARIATIONS IN WEEKLY ELECTRICITY DEMAND

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.

Date: JANUARY 1977

FIGURE I-2



MAXIMUM DEMAND IN CALIFORNIA, 1940-1975

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

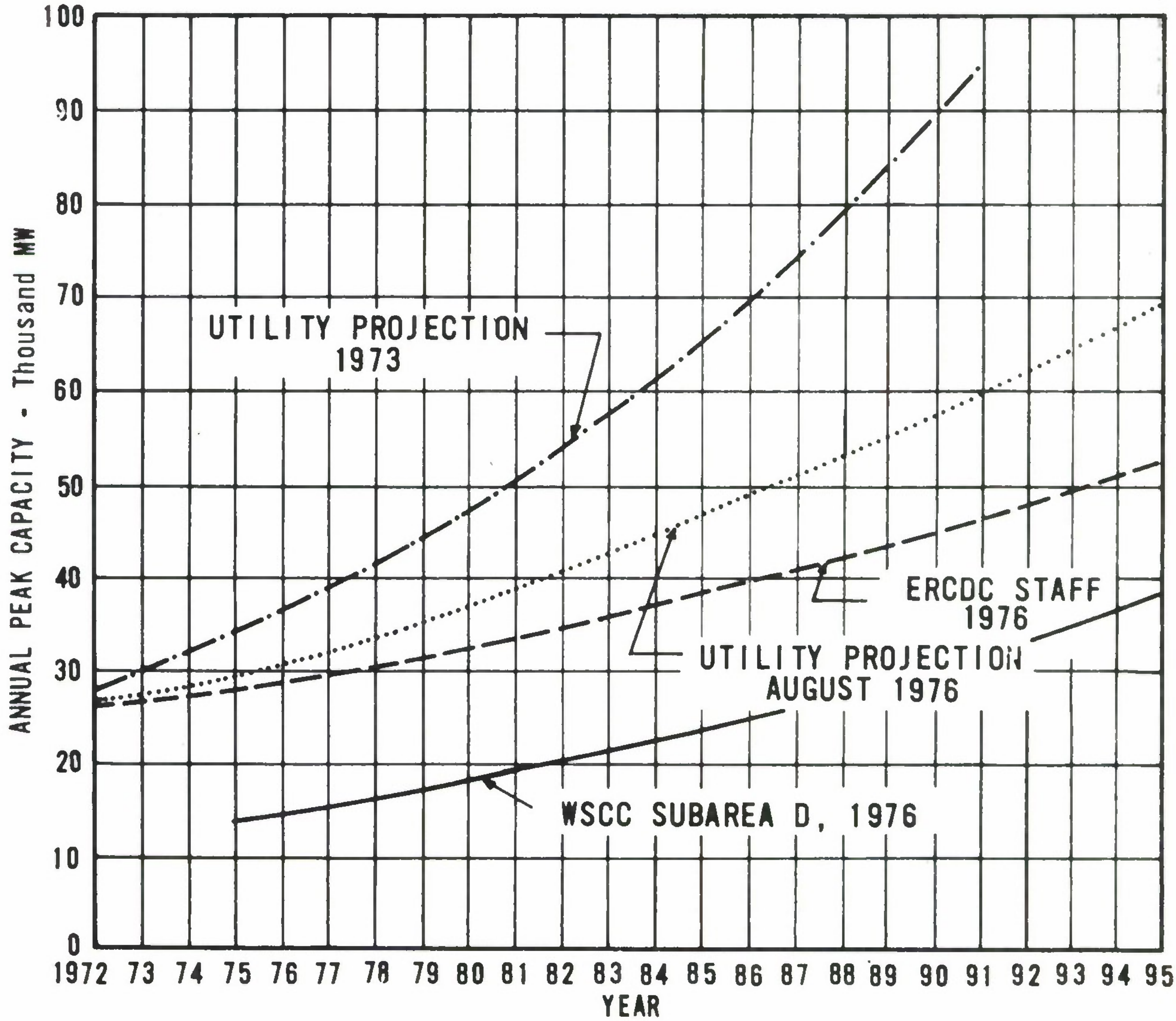
HISTORICAL PEAK POWER DEMAND IN CALIFORNIA 1940-1975

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.

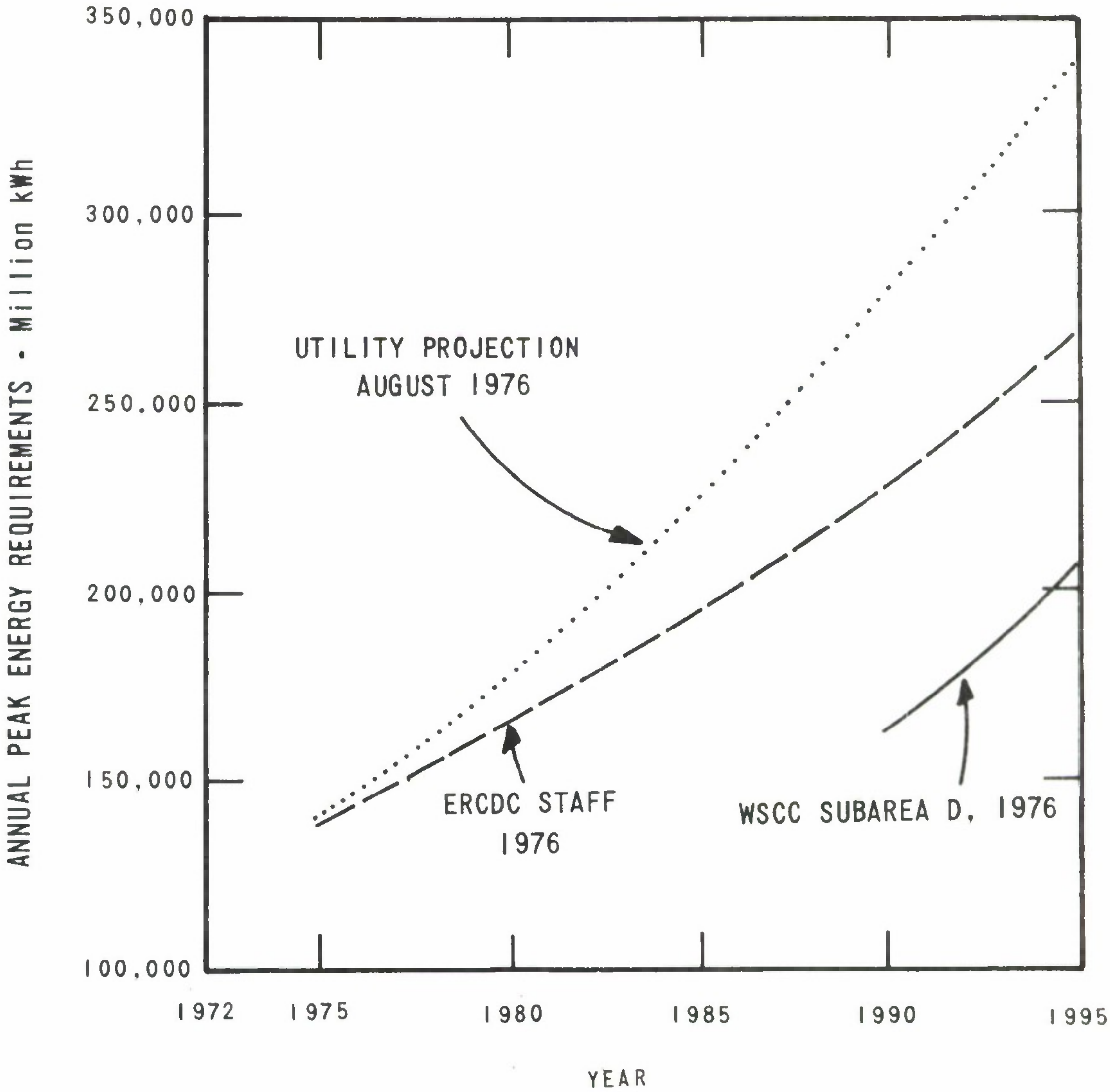
Date: JANUARY 1977

FIGURE I-3



MARYSVILLE LAKE YUBA RIVER, CALIFORNIA FORECASTS OF ANNUAL MAXIMUM PEAK CAPACITY DEMANDS
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L G B Date: JANUARY 1977 Drawn: L K K

FIGURE 1-4



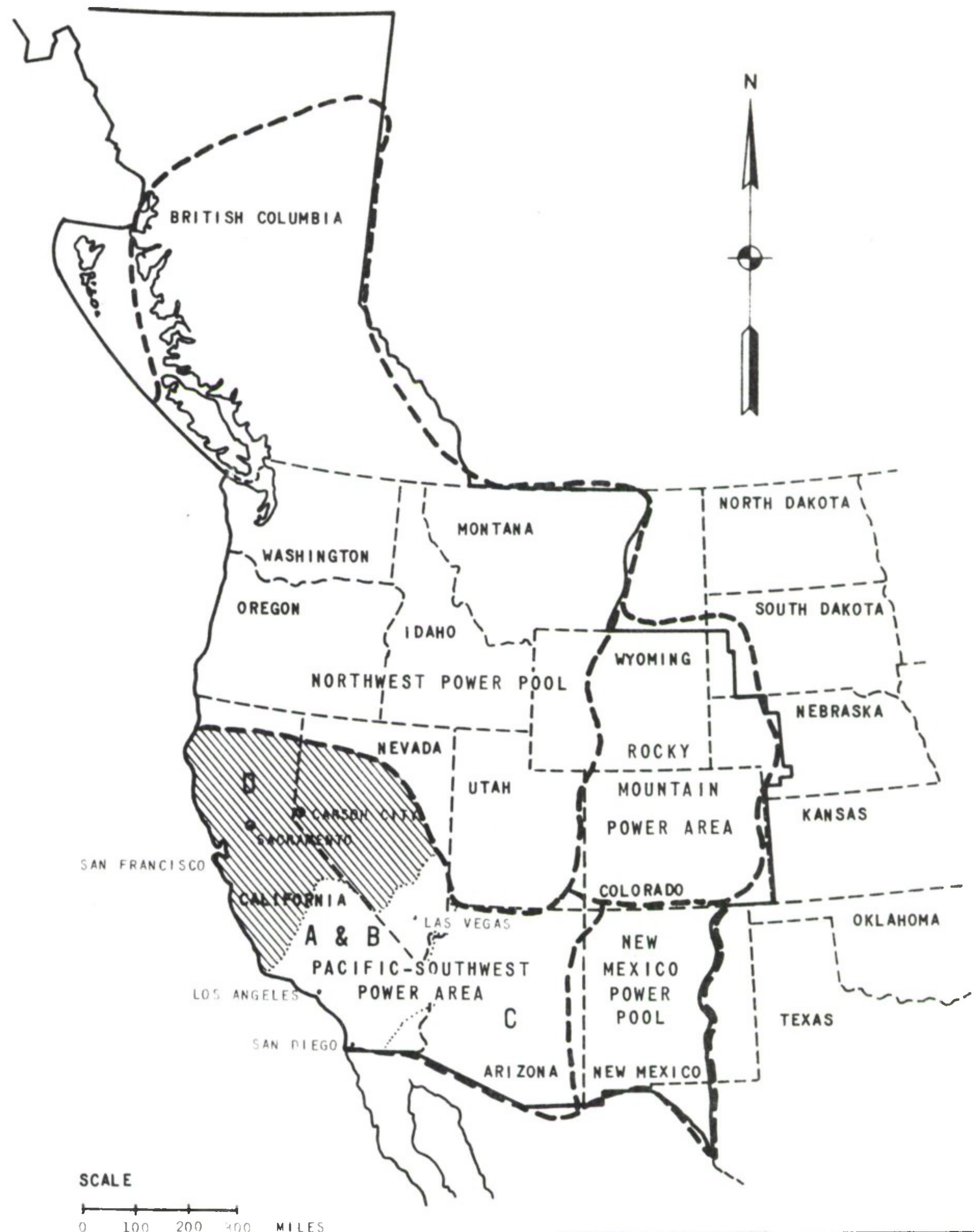
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

FORECASTS OF ANNUAL MAXIMUM PEAK ENERGY DEMANDS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L G B
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE I-5



POWER AREA BOUNDARY

COUNCIL BOUNDARY

SOURCE: WSCC Ten-Year Coordinated Plan Summary, 1976-1984; May '75.

MARYSVILLE LAKE, CALIFORNIA

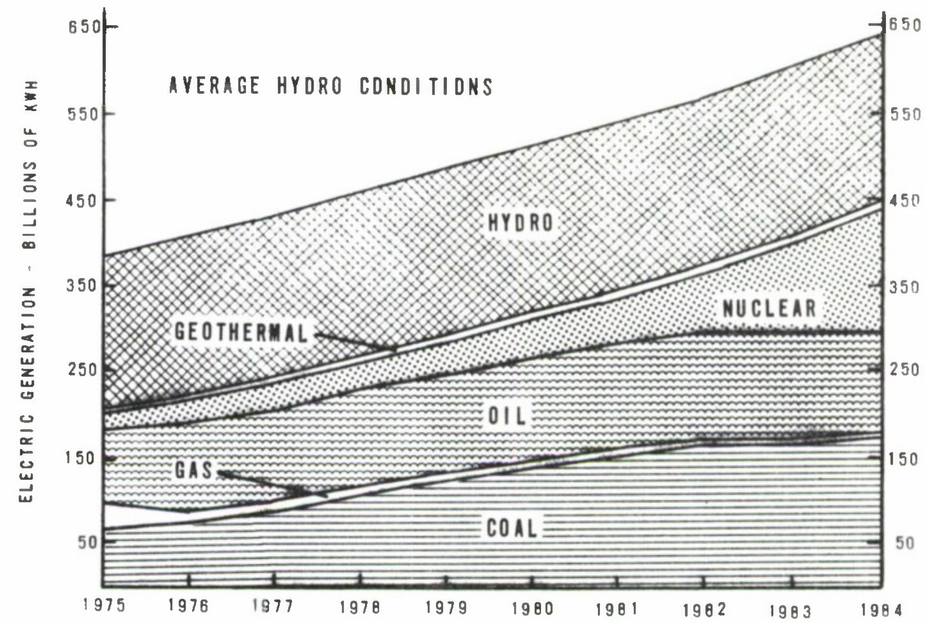
WESTERN SYSTEMS COORDINATING COUNCIL

CORPS OF ENGINEERS SACRAMENTO, CA

Prepared: L.G.B.
Drawn: L.K.K.

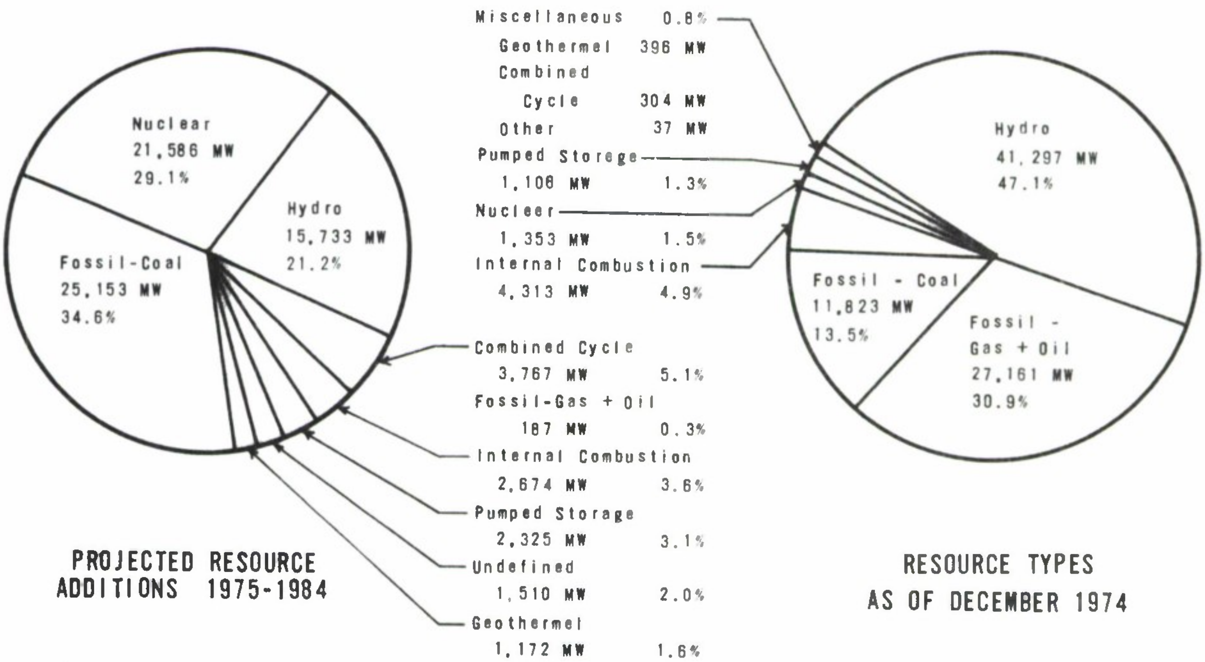
Date: Oct 1976

FIGURE I-6



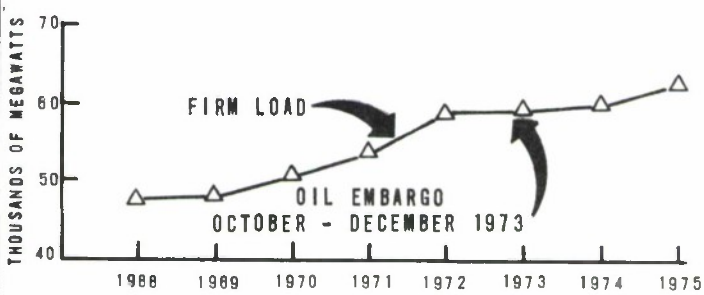
SOURCE: WSCC Ten-Year Coordinated Plan Summary, 1976-1984, May 1975.

ELECTRIC GENERATION - BY SOURCES
(Excluding Canadian Systems)



PROJECTED RESOURCE ADDITIONS 1975-1984

RESOURCE TYPES AS OF DECEMBER 1974



FIRM PEAK LOAD - WSCC

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

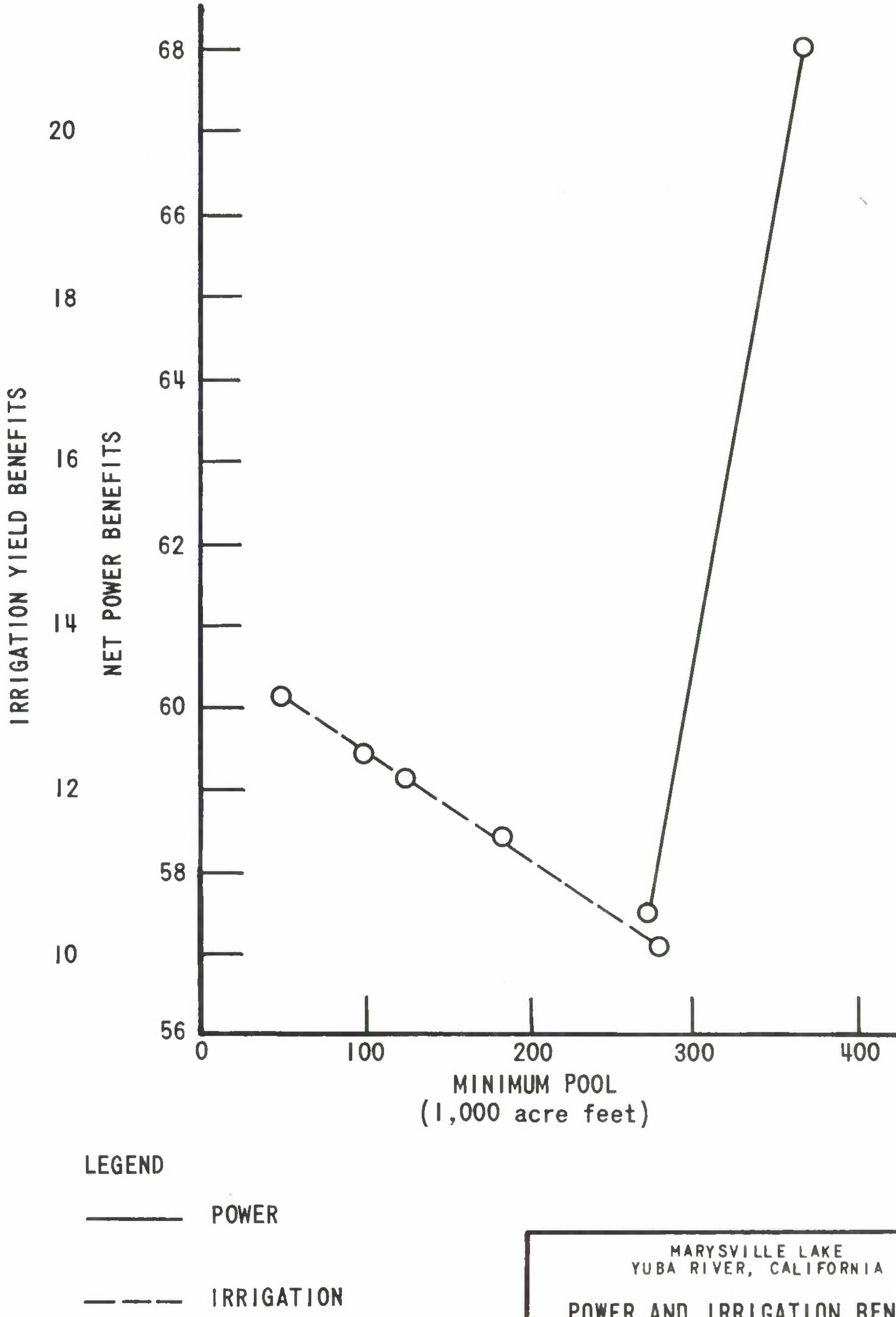
GENERATING RESOURCES

WESTERN SYSTEMS COORDINATING COUNCIL
(WSCC)

CORPS OF ENGINEERS SACRAMENTO, CA

Prepared: L.G.B.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE I-7



NOTE: Based on data at 3-1/4 percent interest rate.

MARYSVILLE LAKE YUBA RIVER, CALIFORNIA POWER AND IRRIGATION BENEFITS AS A FUNCTION OF MINIMUM POOL SIZE - 2,250 MW POWERPLANT	
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA	
PREPARED: L.G.B. DRAWN: L.K.K.	DATE: FEBRUARY 1977

FIGURE I-8

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX J

WATER RESOURCES AND IRRIGATION SUPPLY

APPENDIX J - WATER RESOURCES AND IRRIGATION SUPPLY

Table of Contents

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APPENDIX J - WATER RESOURCES AND IRRIGATION SUPPLY

1. General. -

Studies of water resources and irrigation supply are in two parts: one concerns the local Yuba County service area, and the other concerns the service area for the Central Valley Project (CVP) of the U.S. Bureau of Reclamation (USBR) which will market the yield from the Marysville Lake project.

Studies of water supply yield from the Marysville Lake project are predicated on making releases from the project to satisfy all prior water rights and requirements, including 197,100 acre-feet per year for the Yuba County Water Agency (YCWA) (172,100 acre-feet for irrigation; 25,000 acre-feet for seepage) on an irrigation demand schedule in the months of March through October, on a firm yield basis, subject to normal reductions in low-flow years, all as set forth in the schedule presented in the IECO report "Post-Construction Reservoir Operation and Power Study" dated November 1969. Normal monthly releases from the Marysville Lake project to meet existing downstream diversion rights and requirements and allocations for seepage losses are listed on the next tabulation.

Fixed Releases for Prior Rights and Requirements Below Narrows
(Acre-Feet)

Month	Hallwood & Cordua	B.V.I.D.	Sub-Total	Yuba County Water Agency Seepage Allowance	Yuba County Water Agency Irrigation	Yuba County Water Agency Sub-Total	Total
Jul	22,300	2,500	24,800	5,000	39,500	44,500	69,300
Aug	21,400	2,400	23,800	5,000	34,400	39,400	63,200
Sep	15,600	2,400	18,000	5,000	24,400	29,400	47,400
Oct	10,500	1,200	11,700	5,000	5,700	10,700	22,400
Nov	-	-	-	-	-	-	-
Dec	-	-	-	-	-	-	-
Jan	-	-	-	-	-	-	-
Feb	-	-	-	-	-	-	-
Mar	1,100	-	1,100	-	1,700	1,700	2,800
Apr	8,700	1,200	9,900	-	8,500	8,500	18,400
May	19,500	2,400	21,900	2,000	25,500	27,500	49,400
Jun	21,600	2,400	24,000	3,000	32,400	35,400	59,400
TOTAL	120,700	14,500	135,200	25,000	172,100	197,100	332,300

Fixed releases, as shown for Hallwood, Cordua, and Browns Valley Irrigation District (BVID), were not subject to reductions during years of sub-normal streamflow, however, normal releases for YCWA were. The reduction criteria used are tabulated below. In applying the reduction criteria, full normal releases were made for YCWA until June, and when a reduction is indicated (based on the forecast for that year), it would go into effect from June through October.

Forecast Streamflow % of Normal	% Reduction in Normal New Releases
Above 85	0
51 - 85	15
50 or less	30

The USBR requested assignment of State Applications 20713 and 20714 from the State Water Resources Control Board on 24 September 1968 for the Marysville Lake project. There have been no water rights assigned or granted by the State Water Resources Control Board, pending hearings on the applications. (Hearings have been delayed pending completion of a draft environmental statement on the project.) Based on USBR analysis of present water rights, both upstream and downstream of the project, there is adequate unappropriated water in the Yuba River to provide the supply needed for the project operation. Those water right holders that are downstream of the Yuba River below the Browns Valley site have signed contracts with USBR or are in the process of negotiation. Allowances were made by USBR for upstream future uses in determining if adequate supply remained for the project operation.

2. Yuba County Water Agency. -

The YCWA planned and constructed New Bullards Bar Dam and Reservoir, together with related water supply, power, and recreation facilities as a part of the Yuba River Development Project in the late 1960's, as described in Appendix E. The development was built with receipts from the sale of revenue bonds, a Federal flood control grant, and a State recreation grant. A power purchase agreement with Pacific Gas and Electric Company (PG&E) provides revenue to retire the

bonds as they mature. Releases from the reservoir are made in accordance with the power purchase agreement and are designed to conform to the energy needs of PG&E. Releases from the powerplants flow downstream to be used for irrigation and other purposes.

With proposed reregulation facilities, the YCWA can make available for sale below Englebright 172,100 acre-feet of Yuba River water generated by the New Bullards Bar project. The YCWA currently has contracts to sell approximately 35,000 acre-feet of this amount to various irrigation districts. One of these districts currently has no conveyance facilities for this water and must complete these facilities by 25 February 1978 or the contract is void. The remaining 137,000 acre-feet of water is unsold and flows down the Yuba River to the confluence of the Feather River. In addition to the 172,100 acre-feet, 25,000 acre-feet of new yield of the New Bullards Bar project has been allocated to seepage.

The YCWA is unable to sell or utilize more of its salable water at this time because it was unable to complete all of the proposed facilities for its Yuba River Development Project that included the New Bullards Bar project.(10) Planned facilities not constructed as a part of the Yuba River Development Project were:

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

- An irrigation diversion works, including an afterbay in the area of Smartville, for the reregulation of water from power usage for irrigation.

- The New York Flat project, including a 90-foot high dam and associated facilities that would increase available water for the Yuba County Water District which is headquartered in Brownsville.

- The North Yuba Canal and pumping plant to take water north of the Yuba River to irrigation users.

- The South Yuba Canal System to take water south of the Yuba River to irrigation users.

Without the reregulation facilities, the YCWA is unable to reregulate the flow of water released from New Bullards Bar Dam for power, and peak flows for power production do not coincide with peak irrigation demands from April to October. The following tabulation shows the amount of sold and unsold YCWA water in acre-feet under current operating conditions.(11) The Ramirez Irrigation District is included in the tabulation because it has contracted with the YCWA for water. Its water contracts by month in acre-feet are not included in

the Water Sold Total column since it has not started consuming its contracted water. However, it can be assumed that the Ramirez Irrigation District will provide facilities for obtaining the water before its contract deadline in 1978.

Month	Cordua Irrigation District	Marysville City Wilbur Di Giorgio	(Ramirez Irrigation District)	Available Agency Water for Sale	Water Sold Total	Remaining Water for Sale by Agency
April	900	820	(2,010)	38,100	1,720	36,380
May	2,120	1,085	(3,270)	27,710	3,205	24,505
June	2,080	1,540	(2,745)	25,700	3,620	22,080
July	2,620	1,590	(1,920)	5,660	4,210	1,450
August	2,600	1,567	(1,755)	6,560	4,167	2,393
September	1,180	1,105	(1,500)	10,500	2,285	8,215
October	500	387	(700)	2,900	887	2,013
Total	12,000	8,094	(13,900)	117,130	20,094	97,036

Two facts are evident from this table: (1) the majority of YCWA's currently salable water (78 percent of available agency water for sale) flows in April, May and June, leaving only 22 percent of the remaining salable water to flow from July to October; (2) after present YCWA water is sold, plus the additional water allocation for the Ramirez Irrigation District, the YCWA over-allocates water to its contracts by 470 acre-feet in July. This is critical for future YCWA water contracts to other irrigation users because it would require flow release changes from New Bullards Bar Dam. This would result in power production changes by PG&E. The 117,130 acre-feet of available

agency water for sale is the maximum amount of water that the YCWA can utilize without seriously altering the present power production requirements of PG&E.

Approximately 60 percent of the water presently used for irrigation in Yuba, Sutter, and Butte Counties is ground water, and the extensive use of ground water has caused lowering of the ground water table. Twenty-five years ago in Yuba County, the depth to water was less than 30 feet. Today, the depth ranges from 15 to 90 feet, with the bulk of the wells being below the 50-foot level. Utilization of surface water rights would make it possible for YCWA to develop a conjunctive program for use of ground and surface water that would permit the ground water table in south Yuba County to stabilize or be restored to former higher elevations.

The major local irrigation problem area is in south Yuba County where surface water is required to offset lowering ground water tables. Because of this problem, the YCWA produced a report in January 1968 presenting a plan to eventually rectify the declining ground water table in the area.(12) This South Yuba Water Development report is the result of an intensive study to find the most feasible economic method of supplying water to the area's farmers. One solution, according to this study, is to utilize reregulation provided by the Marysville Lake project which would provide a means of supplying enough water for the entire county project. However, in the event that the Marysville Lake project is not constructed, an

alternative plan was presented that would supply enough water to the proposed service area No. 1 (Brophy and Wheatland Water Districts and unorganized Plumas area), the largest section of the proposed South Yuba Water Development Project. New facilities will be required to transport the water from the river and distribute it throughout the project area, including diversions, conveyance canals, distribution systems, and a drainage system.

The county plan for supplying Yuba River surface water to service area No. 1 of the South Yuba Water Development Project could be in operation by 1987. Water would be derived by streambed percolation and pumping from the existing dredger ponds near Hammonton. The area of effective streambed percolation would be upstream from Daguerre Point Dam, and the point of withdrawal would be from the southernmost dredger ponds located about 2 miles south of Daguerre Point Dam. Water would be conveyed by a continuous channel formed by connecting the existing dredger ponds. The channel would supply water by gravity to a pumping plant of 650 cfs capacity which would supply the main canal. This 650 cfs would be enough water to irrigate 36,200 acres of the 44,000 acres gross area of service area No. 1. Utilizing the dredger ponds as a source of water for irrigation will only satisfy the present requirement of 121,805 acre-feet per year. The ultimate requirement of 173,400 acre-feet per year can be satisfied only with reregulation facilities.

Other uses of YCWA water could be a potential thermal powerplant, other water districts, municipalities, and Beale AFB. The water districts within Yuba County may extend or expand their irrigation facilities, requiring YCWA Yuba River water. Marysville and Yuba City, Linda, and Olivehurst may require increased supplies of water. As of November 1975, Linda has tentatively requested 5,000 acre-feet/year and Yuba City 8,000 acre-feet/year of YCWA Yuba River water supply. Beale AFB has indicated a need for additional supplies of surface water to augment their supplies from ground water which is being depleted in excess of recharging capabilities.

There appear to be many potential users of YCWA water supply for the future, and based on available information, YCWA has sufficient rights to meet local needs for water. However, without some type of reregulation facility, a problem arises between irrigation and power uses. If the YCWA expands its present (35,000 acre-feet/year) amount of irrigation water without a reregulation facility, water released for power generation would have to be curtailed at certain times of the year to allow a sufficient supply of irrigation water during peak demand. Since the YCWA obtains most of its revenue from power generation, it appears unlikely that it would jeopardize such a steady source of income. The ultimate solution to this problem is the construction of a reregulation facility.

If the South Yuba Water Development Project is constructed, the YCWA should be able to supply 120,000 acre-feet of salable irrigation water to that project. However, if no reregulation facility is constructed, the sale of 120,000 acre-feet of water will involve curtailment of water for power releases from New Bullards Bar and Englebright Reservoirs. If a reregulation facility has been built, there should be no curtailment of power releases.

In July 1976, the engineering firm CH2M Hill issued a preliminary report on water resources and potential supplies in Yuba County.(13) That report identified the following potential water needs and supplies north of the Yuba River. (The location of these districts is shown on Figure J-1.)

Potential Needs	Ac-Ft	Potential Supplies	Ac-Ft
Yuba County Water District	27,000	Oroville-Wyandotte	4,900
Browns Valley Irrigation District	66,000	New York Flat Project	6,800
Ramirez Water District	30,000	Virginia Ranch Project	33,000
Cordua Irrigation District	72,000	Feather River	4,000
Hallwood Irrigation Company	61,000	Yuba River	192,400
Reclamation District 10	37,000	Ground Water	59,300
City of Marysville	6,400	Reuse of Applied Water	10,000
	299,400		310,400

In addition to the areas listed above, the report identified approximately 5,000 acres of land not within organized district boundaries that are irrigated using ground water. Potential ground water needs for those areas are estimated to equal 20,000 acre-feet, resulting in a total ground water need north of the river equal to 79,300 acre-feet. Safe yield of ground water in the area north of the river and west of Browns Valley Ridge has been estimated by the Department of Water Resources to equal about 50,000 acre-feet per year. Of the projected 79,300 acre-feet needed from ground water, about 10,000 are east of the ridge, resulting in ground water needs

about 19,000 acre-feet greater than supplies available on a safe yield basis. However, apparent excess surface water deliveries to the Hallwood area equal about 11,000 acre-feet, which, if diverted to areas of ground water use, could permit an operation north of the river approximating safe yield of the ground water aquifers.

The CH2M Hill report also identified the following potential needs and supplies for areas south of the Yuba River. (The location of the districts is shown on Figure J-2.)

Potential Needs	Ac-Ft	Potential Supplies	Ac-Ft
Dantoni W.D.	12,000	Feather River	20,000
Brophy W.D.	50,000	Ground Water	94,000
Wheatland W.D.	56,000	Yuba River (existing)	17,900
Plumas Unorganized	54,000	Yuba River (future)	154,200
Reclamation District 784	44,000	Reuse of Applied Water	10,000
Domestic	24,200	Total	296,100
Industrial	50,000		
Total	290,200		

In addition to the areas listed above, Yuba Goldfields, Inc. has approximately 12,000 acres adjacent to the south bank of the Yuba River to which diversions have been made since 1904. However, most water use in this area has not been consumptive. Safe yield of the

ground water in the area south of the river has been estimated by the Department of Water Resources to equal 90,000 acre-feet per year. The projected 94,000 acre-feet per year needed from ground water is roughly equivalent to this safe yield supply. To arrive at the safe yield operation level and provide for future industrial needs, an additional 154,200 acre-feet will need to be diverted each year to the southern portion of the county from the Yuba River. A minor part of this additional supply might be provided from the 5,900 acre-feet available to the Dantoni area which is in excess of its needs. The urgency of delivery of this water to the south county area is indicated by the continuing drop in ground water pumping levels. Present ground water pumpage in the area is estimated to equal about 120,000 acre-feet per year or 30,000 acre-feet more than the safe yield level. Based on DWR specific yield estimates for the area, such an overdraft results in lowering the ground water level about 4 feet each year.

The CH2M Hill report concluded that present needs in Yuba County are being met by overdrafting ground aquifers and that potential needs have not developed because of a lack of facilities to deliver available surface water or lack of assurance that water would be available.

Operation of the Marysville Lake project could provide monthly reregulation of YCWA water as an incidental benefit. This would

eliminate the critical late-season shortage of water such as experienced in 1976 and in other low-flow years, in the local area.

Utilization of Agency rights to Yuba River water would reduce the use of ground water in the service area, thus reversing the lowering of the ground water table that has been occurring in Yuba County in recent years, and make possible improved agricultural practices and improved yield, as well as a small increase in irrigated lands. With more effective water utilization, it would be possible for the Agency to institute a planned program of conjunctive use of ground water and surface water in which surplus water is stored in the ground water basin in wet years and is available to be pumped to supplement surface water supplies in dry years. This would permit the ground water table in south Yuba County to be restored to and stabilize at former higher levels and would reduce the pumping head, reducing power costs to irrigators in the service area.

3. Browns Valley Irrigation District. -

A portion of the Browns Valley Irrigation District (BVID) is within the project area. Irrigation facilities of BVID are shown on Figure J-3. BVID was organized in 1888, and rights to a portion (17,000 acre-feet per year) of the District's present water supply date back to that time, when it acquired the water rights and

conveyance facilities from the owners of canals and ditches constructed by early mining interests.(1) The BVID contains 46,379 acres; 16,211 acres are suitable for irrigation and, of this amount, nearly 10,000 acres are steep and require special irrigation practices. By 1970, the irrigated area reached 4,400 acres, considerably less than the amount expected with full development.(4) The plan for the BVID assumes that the net area irrigated in any season would not exceed 11,100 acres.

On 20 September 1960, BVID executed a Small Projects loan contract with the USBR for construction of Virginia Ranch Dam and Reservoir, a tunnel, new canals, a pumping plant and enlargement of existing canals for the purpose of delivering water for irrigation to the lands within the district. Virginia Ranch Dam was completed and accepted from the contractor in December 1963. Construction of the distribution system was completed in May 1965. The district's total loan obligation to the USBR was $4,797,071.40; and of this amount, approximately $3,800,000 is remaining. The approximate annual loan repayment is $100,000.

The district's income derives from sale of irrigation water at $28 per miner's inch (9 acre-feet) to 4,400 acres; taxes on 46,379 acres at $4 per $1,000 assessed valuation, and sale of "falling water" for power generation at Narrows and Colgate Powerplants ($74,000 annually). The "falling water" revenue results from BVID allowing a part of their appropriated water to flow through the powerplants rather than diverting it upstream.

In the order of 12,100 acres (26 percent) of BVID land would be required for the Marysville Lake project, including 2,500 acres (15 percent) of irrigable land in the district, resulting in a revenue loss of an estimated $8,000 per year. Irrigable land to be taken includes 150 acres of Class 3 land and 2,350 acres of Class 4 land. It is estimated that the land to be taken includes 1,100 acres (25 percent) of the lands presently under irrigation. BVID would lose in the order of $10,000 annually from sale of water to these irrigated lands. Construction of the Marysville Lake project would also require the taking of two ditches, Ellis and Sicard Flat Ditches, to which BVID owns a prescriptive right.

Most of the power generated by BVID's "falling water" is produced at Colgate Powerhouse, and would not be affected by the selected plan. It is possible that about $8,000 (the amount allocated to Narrows) of the revenue might be lost, although it appears that BVID's power contract would bind the power company to continue to make the entire $74,000 payment regardless of whether the Narrows plant is operable.

Reimbursement for the two irrigation ditches inundated is included in the project costs. The loss of future revenue due to reduced assessed valuation and water sales is considered consequential damage, and is not compensable.

4. Central Valley Project. -

a. General. - The Central Valley Project (CVP) of the U.S. Bureau of Reclamation, shown on Figure E-6, Appendix E, is a multiple-purpose development that includes the storage and transfer of surplus water from the Sacramento and Trinity River basins to water-deficient lands of the San Joaquin River and Tulare Lake Basins. Events leading to establishment of the project and project features are discussed in paragraph 2d, Appendix E. The service area of the CVP, shown on Figure E-6, encompasses 28 counties, extending about 400 miles north to south and about 40 miles wide. The CVP is separate from the California State Water Project, although certain pumping and canal facilities are shared.

Operating plans for the CVP are prepared on the basis of median forecasted inflow data and corresponding system demand data. These plans are also evaluated on the basis that upper- or lower-quartile water supply conditions may occur so that the water supply available is put to optimal use. Operational forecasts for the project are based on the concept of basinwide integration to provide the greatest utilization of the available CVP water resources. Under this concept, operation is dependent upon the total water supply regardless of source.

Most of the water users obtain their water deliveries from or via CVP facilities located on the Sacramento and San Joaquin Valley floors. The principal interests currently being provided a water supply by the CVP are:

- Exchange contractors and other users located downstream from CVP facilities with entitlements to use water.

- Irrigation, municipal and industrial users adjacent to the Sacramento River.

- Users located within the Sacramento-San Joaquin Delta.

- Irrigation, municipal, and industrial users supplied water from the Delta-Mendota, San Luis, Friant-Kern, Madera, Tehama-Colusa, Corning, and Contra Costa Canals.

- Waterfowl conservation and recreation users delivered water from various CVP facilities.

b. Available water supplies. - In 1973, the CVP delivered 6 million acre-feet of water. Most of this was used for agriculture, municipal and industrial, and fish and wildlife purposes, with

2,464,320 acre-feet used for water-right purposes. The firm annual water supply available to the CVP from existing and authorized facilities is 11,402,116 acre-feet, including prior vested water rights. Sources of this supply are shown in the next tabulation.(5)

Facility or Service Area		Supply (acre-feet)
Central Valley Project		9,250,000
Existing facilities		(8,932,000)
Authorized facilities (Auburn)		(318,000)
Other reservoirs		532,800
Existing facilities		82,000
Sly Park		(23,000)
Black Butte		(59,000)
Authorized facilities		445,800
New Melones		(245,000)
Marysville		(150,000)
Hidden		(24,000)
Buchanan		(24,000)
Sugar Pine		(2,800)
Other service areas		1,624,316
Existing facilities		1,624,316
Placer County water rights		(120,000)
Friant Division		(1,504,316)
	Total	11,402,116
SUMMARY		
Existing facilities		10,638,316
Authorized facilities		763,800
	Total	11,402,116

c. Contracted water. - The CVP supply already contracted for totals 9.1 million acre-feet, and the present anticipated demand for CVP water totals 10.8 million acre-feet, as shown in the next tabulation.

	Supply under contract (1972) (ac-ft)	Demand (ac-ft)
Sacramento Valley	2,736,904	3,730,395
American River	864,600	1,617,600
Delta	3,162,051	3,681,500
San Joaquin Valley	2,342,000	1,785,316
Total	9,105,555	10,814,811

In addition, the USBR and State of California are jointly studying feasibility of a Mid-Valley Canal, planned for 1985 service, to partially stem overdraft conditions on the east side of the San Joaquin Valley that would require another 650,000 acre-feet, making the total anticipated demand for CVP water 11.5 million acre-feet.(5) The projected buildups in use of water in the various CVP service areas from 1975 to 2030 are presented in the next tabulation.(6) The buildups include both irrigation and municipal and industrial water.

BUILDUP IN USE OF CVP WATER
(1,000 acre-feet)

Sacramento Basin Service Areas	1975	1980	1985	1990	2000	2010	2020	Ultimate
Sacramento Valley								
Shasta Area & Toyon Pipeline	2	2	3	3	4	5	5	9
City of Redding & Spring Creek Conduit	4	6	7	9	10	11	11	11
Clear Creek South	4	13	17	17	17	17	17	31
Sacto Canals & Cow Creek	58	197	361	477	576	653	729	729
Feather River W.D.	20	20	20	20	20	20	20	20
Sacramento Water Users	2,723	2,730	2,736	2,742	2,755	2,767	2,780	2,934
Subtotal	2,811	2,968	3,144	3,268	3,382	3,473	3,562	3,734
American River								
Foresthill Divide	0	2	2	2	2	3	3	3
No. Fork, Natomas, Folsom Prison	69	69	69	69	69	69	69	69
San Juan Suburb & Roseville	13	17	23	27	43	51	51	51
City of Sacramento	56	68	80	92	123	156	194	230
El Dorado County	4	6	6	6	6	6	6	6
El Dorado County Water Rights	13	18	21	26	47	104	104	104
Placer County Project Water	0	0	0	0	35	117	117	117
Placer County Water Rights	15	20	25	30	55	120	120	120
Malby	0	0	2	7	17	25	25	25
Subtotal	160	200	228	259	397	651	689	725
Export Service Areas								
American River								
Folsom-South Canal at Nimbus	32	130	351	550	875	875	875	875
Subtotal	32	130	351	550	875	875	875	875
Delta								
Exchange, Schedule 2, and DMC Losses	997	997	997	997	997	998	998	998
DMC Irrigation & Grasslands	507	664	665	666	672	677	677	677
Contra Costa Canal	105	135	172	188	195	195	195	195
San Luis Unit	1,255	1,448	1,465	1,470	1,475	1,475	1,475	1,475
San Felipe	0	0	77	119	152	178	196	216
Cross Valley	0	128	128	128	128	128	128	128
Folsom So. Svc Area from Delta	0	0	0	0	1	80	90	90
Mid-Valley Canal	0	0	650	650	650	650	650	650
Subtotal	2,864	3,372	4,154	4,218	4,270	4,381	4,409	4,429
San Joaquin Valley								
Friant Division	1,504	1,504	1,504	1,504	1,504	1,504	1,504	1,504
Hidden Project	11	24	24	24	24	24	24	24
Buchanan Project	24	24	24	24	24	24	24	24
Sly Park Unit	23	23	23	23	23	23	23	23
New Melones Project	0	0	32	82	200	210	210	210
Subtotal	1,562	1,575	1,607	1,657	1,775	1,785	1,785	1,785
TOTAL DEMAND	7,429	8,245	9,484	9,952	10,699	11,165	11,320	11,548

In addition to contracts included within the 9.1 million acre-feet CVP supply under long-term contract discussed above, the USBR has recently contracted with Cross-Valley Canal interests for 128,000 acre-feet; is nearing completion of negotiations with the Santa Clara Valley Water District for a portion of the San Felipe service (152,500 acre-feet, which will be limited to 137,500 acre-feet if reclaimed wastewater proves feasible by 1990); is negotiating for 43,800 acre-feet of San Felipe supply to San Benito County; has reserved 20,000 acre-feet of San Felipe service until 1990 for possible use by the Watsonville area and/or Monterey County; is negotiating with California Department of Water Resources for up to 300,000 acre-feet of interim water sales (1976 to 2000 with quantity adjustable every 5 years); and the Westlands Water District and other San Joaquin Valley water users are presently purchasing some 250,000 acre-feet of water annually in excess of the long-term unit supply.

Computation of the water supplies available to the CVP was based on a Delta outflow of 1,800 cfs which, with the proposed Peripheral Canal in operation, is deemed sufficient to meet Delta criteria agreed to by representatives of Delta water user groups. Current analysis of flow and water quality data for the Delta indicates that the Delta outflow should be increased to 2,500 cfs to meet 19 November 1965 criteria. On an annual basis this flow increase of 700 cfs would require about 300,000 acre-feet to meet the CVP share of outflow. Since this would place additional demands on developed CVP water supplies, the anticipated demand for CVP water would be increased by 300,000 acre-feet, or to 11.8 million acre-feet.

Different assumptions as to Delta water quality to be maintained, other than 19 November 1965 criteria, and cross-Delta conveyance facilities other than the Peripheral Canal would further affect CVP water supply versus demand computations. For example, meeting the outflow requirements of the California State Water Resources Control Board's (SWRCB) Decision 1379 -- if it were applicable to CVP operation -- without a proposed Peripheral Canal and without overland water supply facilities for the western Delta would increase demand on CVP yield by another 2.2 million acre-feet. Therefore, meeting Decision 1379 criteria in the Delta would increase the anticipated demand for CVP water by 2.2 million acre-feet, or to 14.0 million acre-feet, versus a developed CVP water supply of 11.4 million acre-feet.

Decision 1379 of the SWRCB contained quality criteria that were interim in nature (reconsideration provided for by, or before, 1978) and were subject to relaxation upon construction of substitute water supply facilities in the Delta. Decision 1379 was not implemented for the CVP because of a lawsuit brought by San Joaquin Valley water users. Basin plans and quality criteria contained therein were prepared by SWRCB pursuant to provisions of Public Law 92-500. Water quality criteria proposed for the Central Valley and San Francisco Bay area have been approved by the EPA. The plans may be revised periodically as new data become available, in accordance with Public Law 92-500.

SWRCB plans hearings on dry-year water quality criteria for the Delta and Suisun Marsh which could alter present quality criteria developed for these areas and adopted by EPA.

The Bureau of Reclamation and DWR are negotiating water service contracts with Delta agricultural water users which would state the quality of water required to meet their needs. These contract quality criteria should impact on the determination of Delta quality of water criteria for agriculture to be maintained by enforcement provisions of EPA and SWRCB.

The Bureau, DWR, California Department of Fish and Game, and the U.S. Fish and Wildlife Service have been engaged for several years in Four-Agency ecological studies of the Sacramento-San Joaquin Delta, an objective of which is to determine water quality conditions required for protection of Delta fish resources under future conditions of cross-Delta water conveyance. Data generated by this study will further define Delta water quality criteria.

Also, lawsuits and/or appeals of judicial decisions with respect to SWRCB Decisions 1379, 1400 and 1422 will impact on water quality criteria to be maintained as a responsibility of CVP operations.

d. Need for Marysville Lake water. - The USBR indicated by letter dated 2 April 1976, included in Appendix B, that the yield of the Marysville Lake project can be used for meeting CVP water service demands as soon as the project can be constructed.

5. Delta Export needs. -

The California Department of Water Resources reported in October 1976 (2) on a study of Delta export needs and capabilities for the combined Federal Central Valley Project and the State Water Project (CVP and SWP). Estimated needs and capabilities of the combined systems for the period 1976 - 2000 are shown in Figure J-4. The data indicate that, considering lower growth rates, delayed construction of the Mid-Valley Canal, and waste water reclamation, the combined CVP-SWP estimated needs can be reduced to 8.3 million acre-feet in the year 2000, and that, considering water conservation, the estimated net need can be reduced to 7.8 million acre-feet per year. Under these conditions, the potential shortage in Delta supplies is 1.4 million acre-feet in the year 1990, increasing to 2.6 million acre-feet in the year 2000, as shown on Figure J-4. The following tabulation shows projected year 2000 requirements under wet, normal, dry, and critical dry conditions, together with conjunctive use of ground water south of the Delta, Delta diversions, and Delta outflow in millions of acre-feet per year.(2)

	Type of Water Year			
	Wet	Normal	Dry	Critical
SWP-CVP Service Area Requirements	8.3	8.3	7.3	6.1
Waste Water Reclamation	-0.1	-0.1	-0.1	-0.1
Water Conservation	-0.4	-0.4	-0.4	-0.4
Net Delivery	7.8	7.8	6.8	5.6
State Water Project	(3.5)	(3.5)	(3.2)	(2.6)
Central Valley Project	(4.3)	(4.3)	(3.6)	(3.0)
Ground Water Recharge or Extraction	+0.6 to 1.4	+0.4	-0.2	-0.6
Delta Diversion	8.4 to 9.2	8.2	6.6	5.0
Delta Uses	1.6	1.6	1.6	1.6
Delta Outflow 1/	3.6	3.6	3.6	3.6

1/ Will be modified by 4-Agency Agreement.

The foregoing tabulation is based on storage of excess water supplies south of the Delta in normal and wet years for utilization to reduce Delta diversions by 200,000 acre-feet in dry years and 600,000 acre-feet in critical dry years.

6. Sacramento-San Joaquin Delta flows. -

The average annual runoff of the Yuba basin is in the order of 1,850,000 acre-feet, or about 10 percent of the total runoff of the Sacramento basin. USGS records indicate that in the period 1922

through 1974 basin runoff has exceeded 3,000,000 acre-feet per year in 9 years, with the highest runoff, 3,915,000 acre-feet, having occurred in water year 1952. USGS records also indicate that minimum basin runoff of less than 500,000 acre-feet occurred in water years 1925 and 1931.

The plan of operation for the Marysville Lake project is to draw the lake down to the base of the flood control pool each winter and to refill the lake to gross pool during periods of high runoff in late winter and spring after the flood hazard is reduced. After initial filling of the reservoir, on the average over the 77 years of the simulated operation study for the years 1895-1971, the volume of water stored in the lake each year would be 270,000 acre-feet. Operation of the project would, thus, on the average, modify the timing of occurrence of 270,000 acre-feet of Delta inflow each year from late winter and spring to other periods of the year when flows are needed for water supply and for fishery in Yuba River. The historical inflow to the Sacramento-San Joaquin Delta from the Sacramento and San Joaquin Rivers over the 1944-1970 period was in the order of 22,100,000 acre-feet annually. The Department of Water Resources estimates that the average annual Delta inflow would have been 19,794,000 acre-feet for the 1921-1954 period assuming all water projects in existence in 1970 had been operated throughout the period to meet demands at the 1970 level of development.(3) Thus, operation of the Marysville Lake project would modify the timing of occurrence of in the order of 1.4 percent of the total Delta inflow from late winter and spring to other periods of the year.

In 1974 the maximum authorized and contracted demands for export from the Delta were 3,444,000 acre-feet for the CVP and 4,474,000 acre-feet for the SWP, or a total of 7,940,000 acre-feet.(3) Firm water supply yield from the Marysville Lake project is 150,000 acre-feet annually, and utilization of this yield for supplemental Delta export supply would increase the export by about 1.9 percent. Only water surplus to needs in the Delta would be stored in Marysville Lake; when Yuba River flows are required to maintain minimum Delta outflow and such flows would have been available from the Yuba River without the Marysville Lake project, no water would be stored in Marysville lake.

7. Food supply. -

Prior to 1972 the United States had large grain reserves, but wheat sales in 1972 and a less than optimal harvest in 1974 eliminated the surplus. Also, poor crops in other countries in the early 1970's brought food supplies in many areas of the world to a critical level. The United States has sought to develop and maintain a strategic reserve of food to offset years of poor agricultural production, and agricultural output in the United States has shown a steady increase over the last 20 years; however, the probability that the past and present pattern of favorable climate will continue is limited.

United States agricultural exports have increased significantly in recent years, as shown in the following tabulation.(7) In particular the value of agriculture exports to developing countries has increased.(7)(8)(9)

Year	Million Dollars
1965	$ 6,100
1970	6,700
1972	8,000
1973	12,900
1974	21,300
1975	21,600

The value of agricultural exports to developing countries was up 16 percent in fiscal year 1975, with the greatest proportionate increases in exports to Iran, India, Iraq, Turkey, Portugal, and Bangladesh.(7) U.S. exports to the Arabian Peninsula have tripled since 1973, reaching $168.7 million in 1975, and are expected to range between $230 and $280 million in 1976.(8) Agricultural exports to Iran increased from $43 million in 1971 to $757 million in 1975. Fiscal year 1975 exports were valued at 23 percent of farm cash receipts. In 1974, 96 million acres, or 3 out of every 10 harvested, were used for the production of crops for export.(9)

There are substantial areas of arable land in the Central Valley that are now dry but are potentially irrigable or are presently water-deficient under current conditions of irrigated farming and water supply. If CVP water were available, these lands could

contribute substantially to food and fiber production in the United States. CVP water is used to produce virtually every climatically adaptable crop which is economically feasible of irrigation in a highly diverse agricultural environment, and in general, this will apply to CVP augmentative supplies, such as Marysville water. Depending on the service area finally selected for use of the water supply yield from the project, localized soil, geographic, and climatic factors may constrain freedom of choice of crops to be grown. Where no such physical constraints apply, irrigators can be expected to select those crops which offer the greatest potential for return. The Marysville Lake project yield could be used to irrigate 58,000 acres of presently unirrigable lands or for supplemental irrigation of about 150,000 acres at a rate of about 1 acre-foot per acre. Use of the project water supply yield for irrigation can be expected to satisfy a portion of the nation's total individual and industrial consumer needs for food and fiber and a portion of the world's needs; however, the increase in production made possible by use of the yield would be small in comparison with State or national production, and the new products should move through normal marketing channels with no discernable impact on the marketability or pricing of products from other areas.

8. Water supply yield of alternative projects. -

Operation study criteria are discussed in Appendix I, Power. These studies, conducted by the Bureau of Reclamation, indicated the water supply yield of various alternative multiple-purpose projects would be as follows when integrated into the CVP.

Site	Water Supply yield (acre-feet)
Browns Valley	150,000
Parks Bar and Dry Creek	150,000
Narrows	150,000
Yuba River only (Parks Bar)	115,000
Edwards Crossing	0

These alternatives are described in Section VI of the Phase I GDM.

The above estimates of yield are based on maximizing project benefits and developing irrigation yield associated with releases for fish (600, 800, and 1,000 cfs) as requested by fish and wildlife agencies while maintaining the highest possible minimum pool for power. The yield for projects at the Browns Valley, Parks Bar and Dry Creek, and Narrows sites could be increased to about 195,000 acre-feet by emptying the reservoirs during the dry cycle; however, studies indicate the power benefits foregone would greatly exceed the increase in benefits associated with the increase in yield.

The computation of irrigation benefits is discussed in Appendix K.

9. Alternative irrigation service areas. -

Since yield from the Marysville Lake project can be completely utilized in several areas of the San Joaquin Valley, no specific service area within the valley has been identified at this time. In estimating irrigation benefits, the USBR derived 10 farm budgets to represent a cropping pattern based on the combined crop acreages of nine San Joaquin Valley counties. The USBR assumed that water from the Marysville Lake project would be used on land that would not

otherwise be productive. Information on possible CVP service areas is summarized in the following paragraphs. Service may be to these areas or to other CVP areas either by exchange or direct service, or to other potential service areas projected to require additional water supply in the future. The service areas are shown on Figure J-5.

a. Folsom South Service Area. - The portion of this service area that would be served by project water includes about 400,000 acres in Sacramento and San Joaquin Counties. The area is located south of the proposed Hood-Clay Connector and would be served by the Connector. Ground water is presently the source of supply for most of the irrigation in the service area; there is some salt water intrusion into the ground water, about 2,000,000 acre-feet of vacated ground water space, and about 60,000 acre-feet per year of ground water overdraft.

b. Southern San Joaquin Valley Service Area. - This service area includes about 4 million acres in parts of Madera, Fresno, Kings, Tulare and Kern Counties. There are unirrigated lands in the service area that can be put into irrigation. In the upper part of the service area surface water supplies are primarily used for irrigation while ground water supplies are used in the lower basin. The San Joaquin-Tulare Basin is estimated to have a ground water overdraft of 1 to 2 million acre-feet per year, and the area has land subsidence and an unfavorable salt balance due to the serious ground water overdraft condition.

c. San Luis Unit. - This service area includes about 600,000 acres on the west side of the San Joaquin Valley in portions of Kings, Fresno, and Merced Counties. Ground water supplies and surface water from the San Luis Canal are used for irrigation, and the USBR has been requested to deliver an additional 300,000 acre-feet, or more, to additional contractors in this service area.

d. San Felipe Division. - This service area includes about 448,000 acres in portions of Santa Clara, San Benito, Monterey, and Santa Cruz Counties. The quality of ground water varies throughout the basin, but in areas of heavy pumping is generally of poor quality for irrigation use. The USBR San Felipe Project, when completed, will supply the immediate needs of the San Benito-Santa Clara portion of the service area until about year 2020, but there will be unmet demands in the Watsonville and Monterey areas. Both the Watsonville and Salinas Valley areas have areas of seawater intrusion, and the Monterey Peninsula area has been having difficulties in meeting their water supply demands due to some salt intrusion in the ground water. Growth will exceed their potential supply in the near future, probably within 10 years.

e. Delta-Mendota Canal Service Area. - This service area includes about 238,800 acres in portions of San Joaquin, Stanislaus, Merced, and Fresno Counties. Imported water for irrigation is largely Sacramento River water imported from the Delta via the Delta-Mendota Canal. Ground water varies greatly in quality and usually contains significant concentrations of boron and sulfate.

APPENDIX J

REFERENCES CITED

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(2) State of California, Department of Water Resources, Delta Alternative Study, Status - October 1976, October 1976.

(3) State of California, Department of Water Resources, Draft Environmental Impact Report, Peripheral Canal Project, August 1974.

(4) U.S. Bureau of Reclamation, Browns Valley Irrigation District and Corps of Engineers Marysville Project, December 1970.

(5) U.S. Bureau of Reclamation, Central Valley Project Operations, Total Water Management Study, Working Document No. 4, January 1975.

(6) U.S. Bureau of Reclamation, Interim Water Supply, Working Document No. 9, Total Water Management Study, March 1976.

(7) U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Trade of the United States, November 1975.

(8) U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Trade of the United States, October 1975.

(9) U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Trade of the United States, September 1975.

(10) Yuba County Grand Jury Final Report, 1972.

(11) Yuba County Water Agency, Letter dated 20 November 1975.

(12) Yuba County Water Agency, The South Yuba Water Development, A Preliminary Report, January 1968.

(13) Yuba County Water Agency, Water Resources and Needs, CH2M Hill, July 1976.

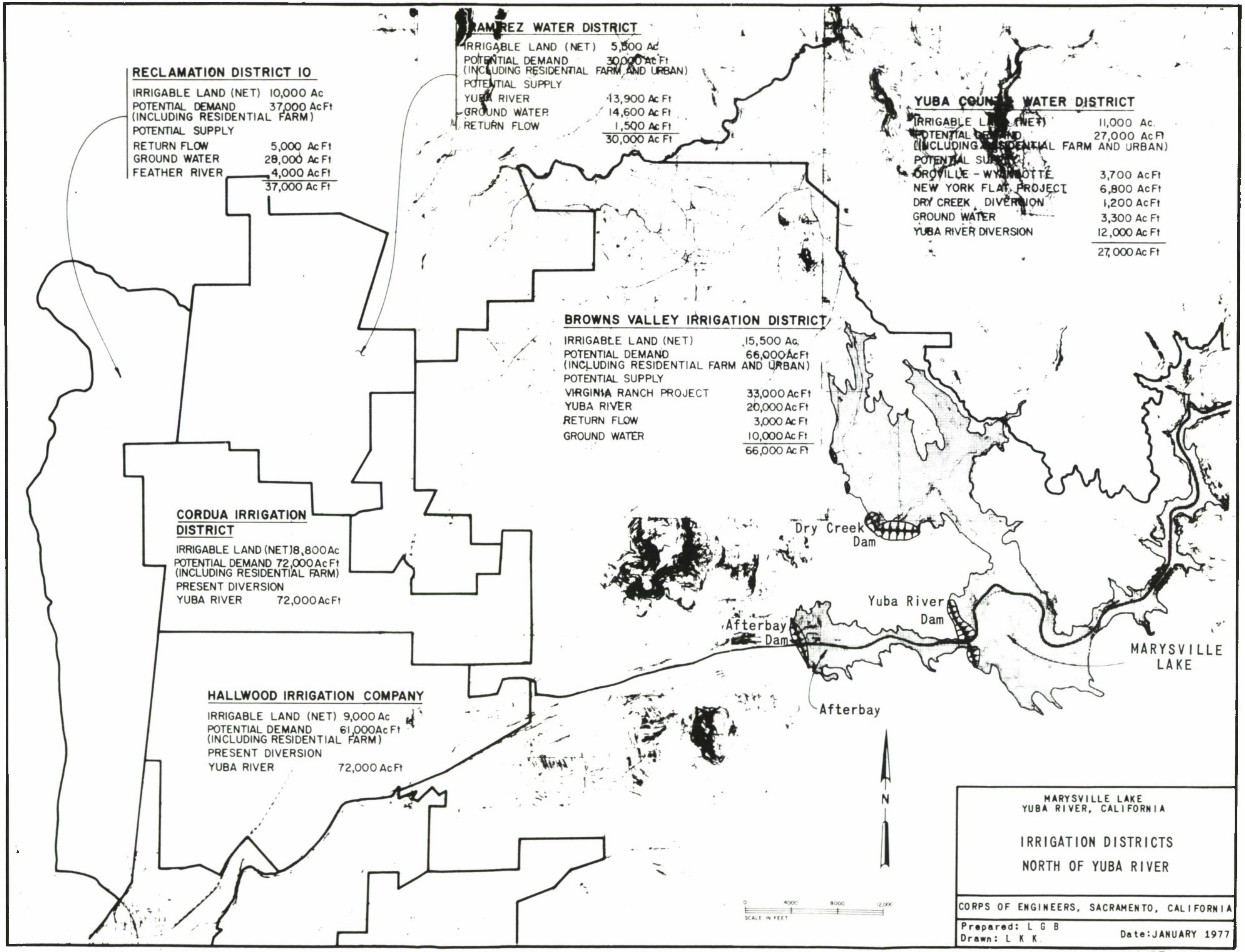

RECLAMATION DISTRICT 10
IRRIGABLE LAND (NET) 10,000 Ac
POTENTIAL DEMAND 37,000 Ac Ft
(INCLUDING RESIDENTIAL FARM)
POTENTIAL SUPPLY
RETURN FLOW 5,000 Ac Ft
GROUND WATER 28,000 Ac Ft
FEATHER RIVER 4,000 Ac Ft
37,000 Ac Ft
RAMIREZ WATER DISTRICT
IRRIGABLE LAND (NET) 5,500 Ac
POTENTIAL DEMAND 30,000 Ac Ft
(INCLUDING RESIDENTIAL FARM AND URBAN)
POTENTIAL SUPPLY
YUBA RIVER 13,900 Ac Ft
GROUND WATER 14,600 Ac Ft
RETURN FLOW 1,500 Ac Ft
30,000 Ac Ft
YUBA COUNTY WATER DISTRICT
IRRIGABLE LAND (NET) 11,000 Ac.
POTENTIAL DEMAND 27,000 Ac Ft
(INCLUDING RESIDENTIAL FARM AND URBAN)
POTENTIAL SUPPLY
OROVILLE - WYANDOTTE 3,700 Ac Ft
NEW YORK FLAT PROJECT 6,800 Ac Ft
DRY CREEK DIVERSION 1,200 Ac Ft
GROUND WATER 3,300 Ac Ft
YUBA RIVER DIVERSION 12,000 Ac Ft
27,000 Ac Ft
BROWNS VALLEY IRRIGATION DISTRICT
IRRIGABLE LAND (NET) 15,500 Ac
POTENTIAL DEMAND 66,000 Ac Ft
(INCLUDING RESIDENTIAL FARM AND URBAN)
POTENTIAL SUPPLY
VIRGINIA RANCH PROJECT 33,000 Ac Ft
YUBA RIVER 20,000 Ac Ft
RETURN FLOW 3,000 Ac Ft
GROUND WATER 10,000 Ac Ft
66,000 Ac Ft
CORDUA IRRIGATION DISTRICT
IRRIGABLE LAND (NET) 8,800 Ac
POTENTIAL DEMAND 72,000 Ac Ft
(INCLUDING RESIDENTIAL FARM)
PRESENT DIVERSION
YUBA RIVER 72,000 Ac Ft
HALLWOOD IRRIGATION COMPANY
IRRIGABLE LAND (NET) 9,000 Ac
POTENTIAL DEMAND 61,000 Ac Ft
(INCLUDING RESIDENTIAL FARM)
PRESENT DIVERSION
YUBA RIVER 72,000 Ac Ft
Dry Creek Dam
Yuba River Dam
MARYSVILLE LAKE
Afterbay Dam
Afterbay
N
0 4000 8000 12,000
SCALE IN FEET
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
IRRIGATION DISTRICTS
NORTH OF YUBA RIVER
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L G B
Drawn: L K K
Date: JANUARY 1977

FIGURE J-1

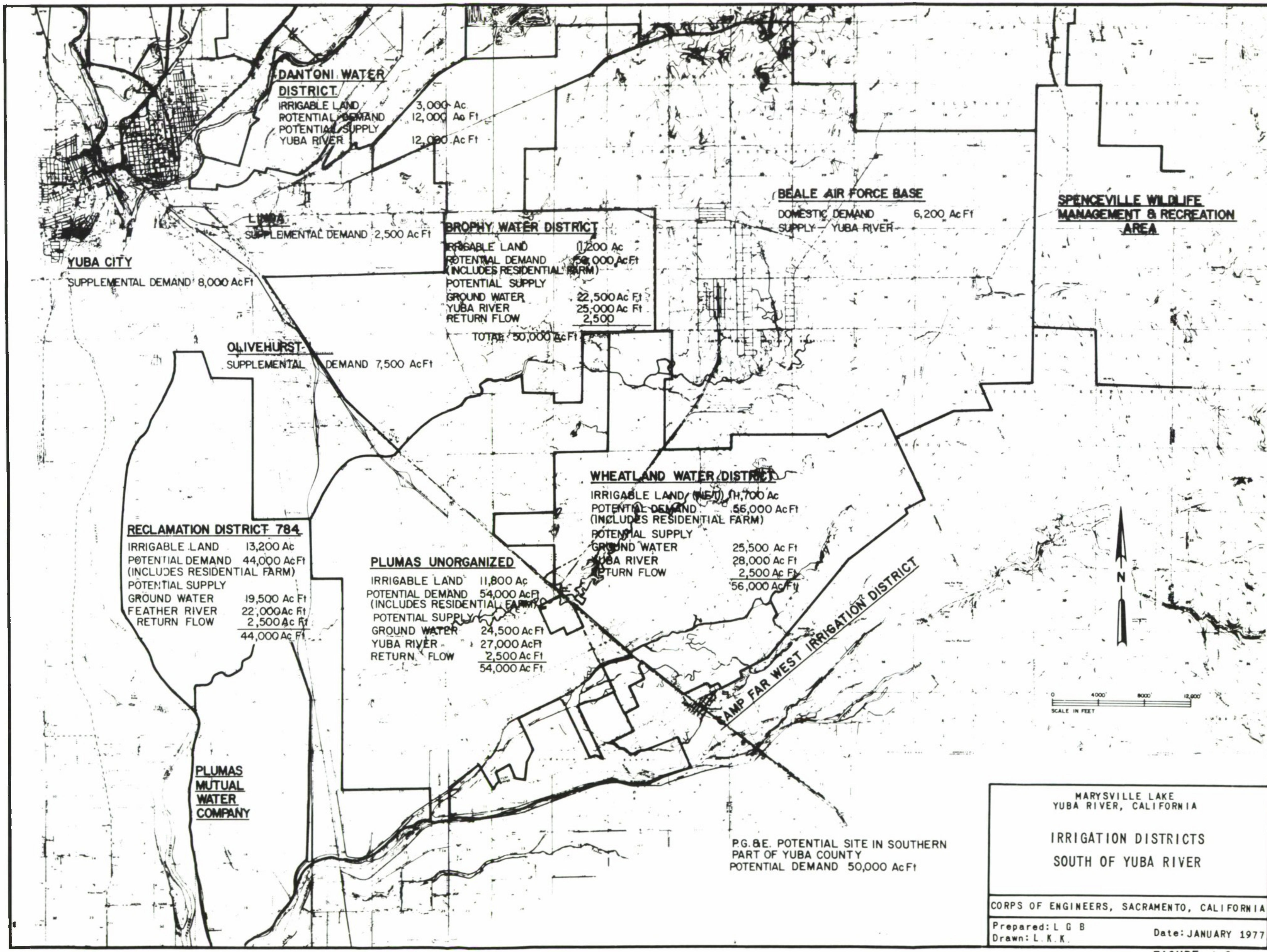

DANTONI WATER DISTRICT
IRRIGABLE LAND 3,000 Ac
POTENTIAL DEMAND 12,000 Ac Ft
POTENTIAL SUPPLY
YUBA RIVER 12,000 Ac Ft
LINDA
SUPPLEMENTAL DEMAND 2,500 Ac Ft
YUBA CITY
SUPPLEMENTAL DEMAND 8,000 Ac Ft
BROPHY WATER DISTRICT
IRRIGABLE LAND 11,200 Ac
POTENTIAL DEMAND
(INCLUDES RESIDENTIAL FARM)
POTENTIAL SUPPLY
GROUND WATER 22,500 Ac Ft
YUBA RIVER 25,000 Ac Ft
RETURN FLOW 2,500
TOTAL 50,000 Ac Ft
BEALE AIR FORCE BASE
DOMESTIC DEMAND 6,200 Ac Ft
SUPPLY YUBA RIVER
SPENCEVILLE WILDLIFE MANAGEMENT & RECREATION AREA
OLIVEHURST
SUPPLEMENTAL DEMAND 7,500 Ac Ft
WHEATLAND WATER DISTRICT
IRRIGABLE LAND (NET) 11,700 Ac
POTENTIAL DEMAND 56,000 Ac Ft
(INCLUDES RESIDENTIAL FARM)
POTENTIAL SUPPLY
GROUND WATER 25,500 Ac Ft
YUBA RIVER 28,000 Ac Ft
RETURN FLOW 2,500 Ac Ft
56,000 Ac Ft
RECLAMATION DISTRICT 784
IRRIGABLE LAND 13,200 Ac
POTENTIAL DEMAND 44,000 Ac Ft
(INCLUDES RESIDENTIAL FARM)
POTENTIAL SUPPLY
GROUND WATER 19,500 Ac Ft
FEATHER RIVER 22,000 Ac Ft
RETURN FLOW 2,500 Ac Ft
44,000 Ac Ft
PLUMAS UNORGANIZED
IRRIGABLE LAND 11,800 Ac
POTENTIAL DEMAND 54,000 Ac Ft
(INCLUDES RESIDENTIAL FARM)
POTENTIAL SUPPLY
GROUND WATER 24,500 Ac Ft
YUBA RIVER 27,000 Ac Ft
RETURN FLOW 2,500 Ac Ft
54,000 Ac Ft
CAMP FAR WEST IRRIGATION DISTRICT
PLUMAS MUTUAL WATER COMPANY
P.G.&E. POTENTIAL SITE IN SOUTHERN PART OF YUBA COUNTY
POTENTIAL DEMAND 50,000 Ac Ft
N
0 4000' 8000' 12,000'
SCALE IN FEET
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
IRRIGATION DISTRICTS
SOUTH OF YUBA RIVER
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: L G B
Drawn: L. K. K.
Date: JANUARY 1977

FIGURE J-2

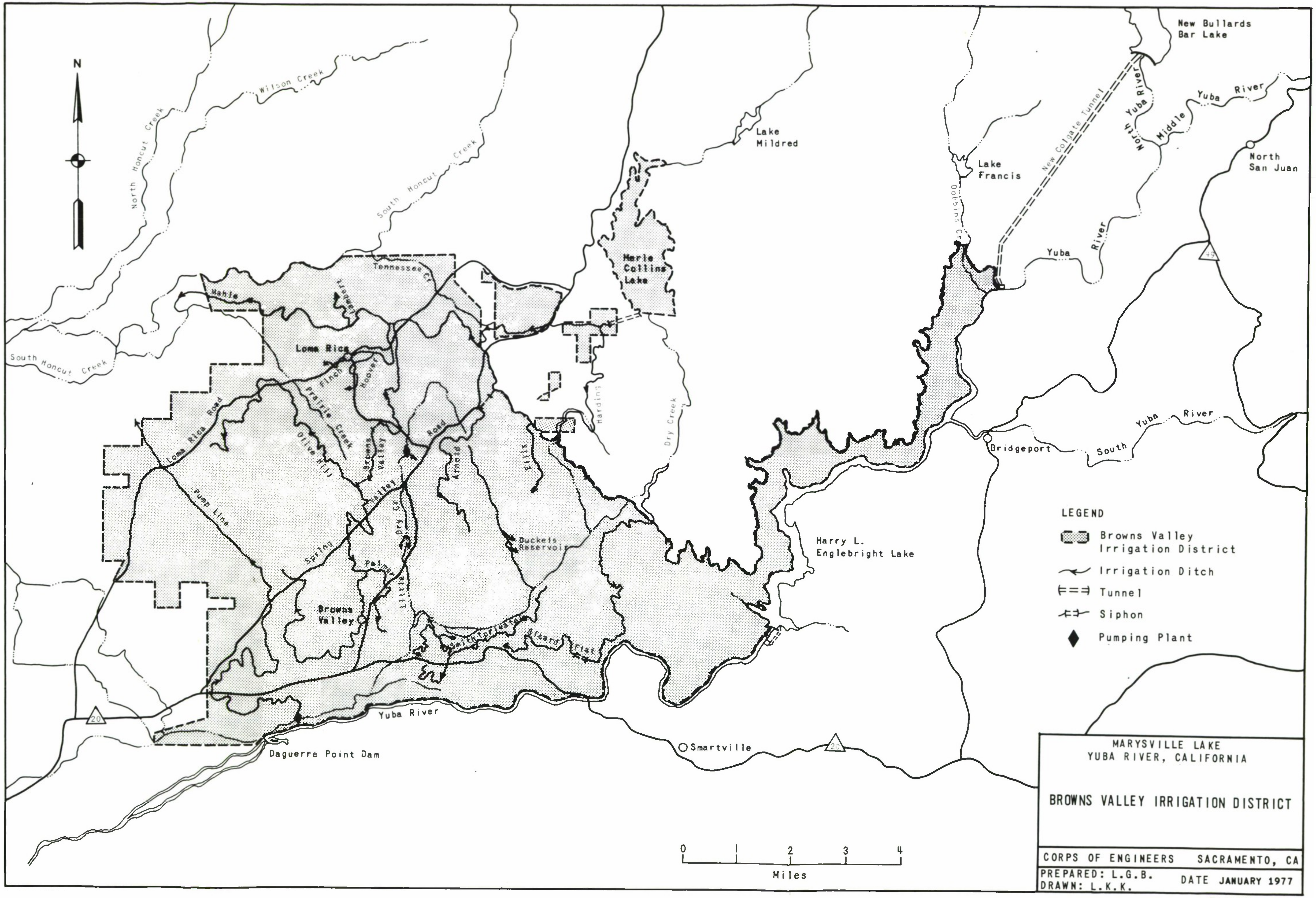
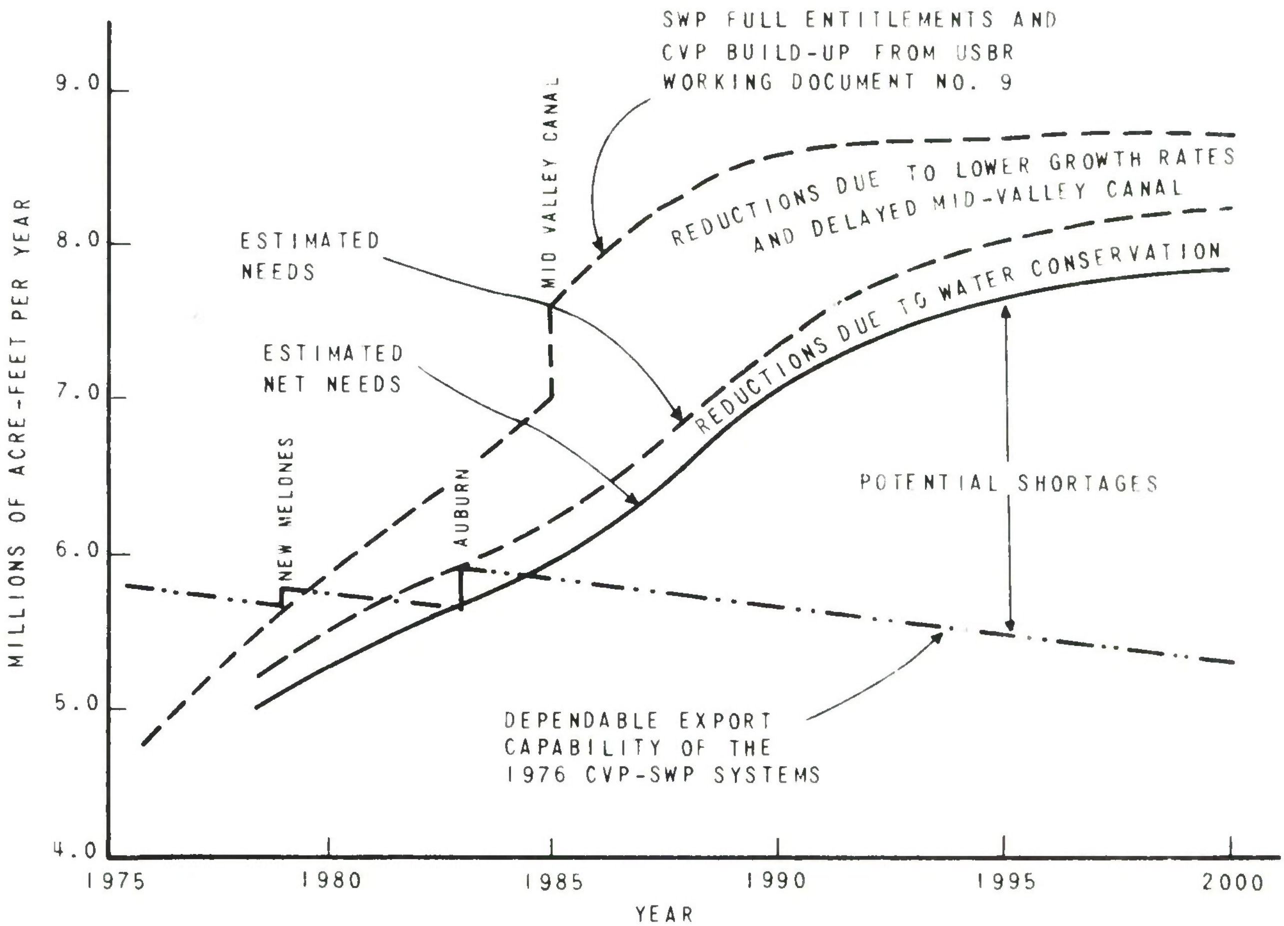

N
Wilson Creek
North Honcut Creek
South Honcut Creek
South Honcut Creek
Tennessee Cr
Mahle
Lambert
Loma Rica
Finch
Hoover
Prairie Creek
Loma Rica Road
Olive Hill
Browns Valley
Road
Valley
Pump Line
Spring
Dry Cr
Palmer
Little
Browns Valley
Arnold
Ellis
Duckels Reservoir
Smith Irrigation
Sicard Flat
Hardin
Dry Creek
Merle Collins Lake
Lake Mildred
Lake Francis
Dobbins Cr
New Colgate Tunnel
New Bullards Bar Lake
North Yuba River
Middle Yuba River
Yuba River
North San Juan
49
South Yuba River
Bridgeport
Harry L. Englebright Lake
Yuba River
Daguerre Point Dam
Smartville
20
20
LEGEND
Browns Valley Irrigation District
Irrigation Ditch
Tunnel
Siphon
Pumping Plant
0 1 2 3 4
Miles
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
BROWNS VALLEY IRRIGATION DISTRICT
CORPS OF ENGINEERS SACRAMENTO, CA
PREPARED: L.G.B.
DRAWN: L.K.K.
DATE JANUARY 1977

FIGURE J-3



SOURCE: Delta Alternative Study.
Status - October 1976.
California Department of
Water Resources

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

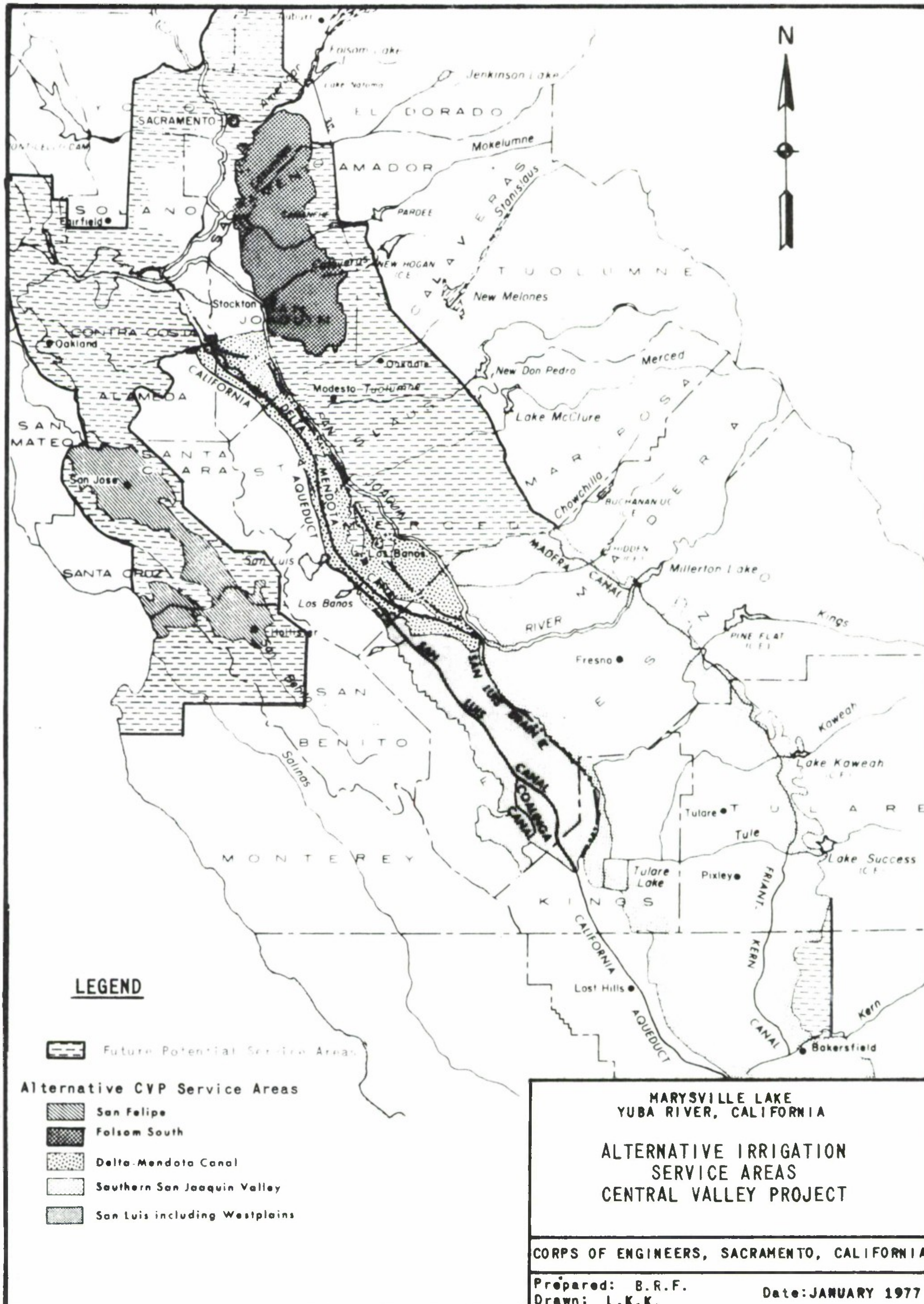
SWP-CVP DELTA EXPORT
NEEDS AND CAPABILITIES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: L.K.K.

Date: JANUARY 1977

FIGURE J-4



N
SACRAMENTO
EL DORADO
AMADOR
SOLANO
Fairfield
Stockton
JOAQUIN
CONTRA COSTA
Oakland
ALAMEDA
SAN MATEO
SANTA CLARA
San Jose
SANTA CRUZ
SAN BENITO
MONTEREY
TUOLUMNE
New Melones
Modesto
New Don Pedro
Merced
Lake McClure
MARIPOSA
MADERA
Chowchilla
Millerton Lake
Fresno
Los Banos
Kings
Kaweah
Lake Kaweah
Tulare
Tule
Lake Success
Tulare Lake
Pixley
KINGS
Lost Hills
Bakersfield
Kern
CALIFORNIA AQUEDUCT
DELTA MENDOTA CANAL
SAN LUIS CANAL
COALINGA CANAL
FRIANT KERN CANAL
MADERA CANAL
Folsom Lake
Jenkinson Lake
Mokelumne
Stanislaus
LEGEND
Future Potential Service Areas
Alternative CVP Service Areas
San Felipe
Folsom South
Delta-Mendota Canal
Southern San Joaquin Valley
San Luis including Westplains
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
ALTERNATIVE IRRIGATION
SERVICE AREAS
CENTRAL VALLEY PROJECT
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: B.R.F.
Drawn: L.K.K.
Date: JANUARY 1977

FIGURE J-5

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX K
SOCIO-ECONOMIC ANALYSIS

APPENDIX K - SOCIO-ECONOMIC ANALYSIS

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APPENDIX K - SOCIO-ECONOMIC ANALYSIS

SECTION I - SOCIAL AND ECONOMIC CONDITIONS

1. Introduction. -

a. Historical background. - Probably the first white man to enter the region was Gabriel Moraga in 1808. There was very little activity in the Sacramento Basin for the next 40 years, with only occasional visits by Hudson's Bay Company trappers. Settlement did not begin until 1841 when Captain John Sutter established a stock ranch in what is now the county named for him. In 1848, gold was discovered in the Yuba River, and mining camps and "mushroom" towns sprang up overnight, causing the population of the area to grow rapidly. Of the eight elaborate townsites in Yuba County laid out as pioneer land speculations, only Marysville survived. The three counties of the flood plain, Yuba, Sutter, and Butte Counties, were all founded in 1850 and were part of the original 27 counties formed at the time California became a state.

The major urban center of the region is in Marysville (Yuba County) and Yuba City (Sutter County). These cities are the center part of an urban complex separated only by the Feather River. The combined population of this urban complex in 1970 was about 39,000 which compels us to recognize it as a metropolitan area. Marysville is the historical trading center of the region, but is bounded by levees and has little room for expansion.

b. Land use. - Land use in the three-county area and the flood plain is shown in the following tabulation. Land use in the area is typical of an agricultural region. The flood plain is comparatively large, encompassing over 526 square miles, and agriculture accounts for 91 percent of that area, but only 68 percent in the three counties. The reason for the difference is that the flood plain lies in the valley where there are no forest lands. About 5.6 percent of the flood plain is conservation and recreation space and over one third of this is part of the Gray Lodge Waterfowl Management Area. Beale AFB also lies on the fringe of the flood plain. There is relatively very little industrial activity except for trailer manufacturing and agricultural related industries such as canneries, elevators, etc. The urban flood plain acreage is comprised of Marysville, Yuba City, Linda, Olivehurst, Biggs, Gridley, Live Oak and a portion of Oroville. Existing land use in the urban area at the junction of the Yuba and Feather Rivers is shown on Figure K-1.

	Yuba, Sutter and Butte Counties		Flood Plain	
	Acres	Distribution	Acres	Distribution
Agriculture	1,255,500	67.9%	305,950	90.8%
Forest	426,200	23.0%	-	-
Conservation and Recreation	94,500	5.1%	19,000	5.6%
Urban 1/	41,100	2.2%	10,600	3.1%
Industrial	10,000	0.6%	1,450	0.5%
Beale AFB	23,000	1.2%	-	-
Total	1,850,300	100.0%	337,000	100.0%

Source: Estimated from Yuba, Sutter and Butte County General Plans and Annual Crop Reports; also agriculture includes some dual use of conservation and recreation land.

1/ Urban acres include the categories of residential, commerical and public facilities.

c. Property values. - The current market value of agricultural lands and urban development in the flood plain, excluding roads and bridges, is estimated to be $1.564 billion. About 50 percent of the value of the flood plain is contained in the residential and mobile home structure and contents categories. Another large category is agriculture which accounts for about 28 percent of the total valuation. The remaining categories are commercial, industrial and utilities, and public and semi-public facilities.

2. Human resources. -

The area immediately surrounding the Marysville Lake project site is rural agricultural, with scattered residences of retired persons and second homes. The closest residential area is Smartville, an unincorporated development with a population of about 200, located along the southern project boundary. About 250 to 300 people reside within a 5-mile radius around the project, in the small communities of Browns Valley, Sicard Flat, and the adjacent area. Loma Rica, a community of more than 300 people, is located about 6 miles northwest of the project. The "twin cities" of Marysville (Yuba County) and Yuba City (Sutter County) are about 16 miles west of the main dam on the Yuba River. Marysville and Yuba City are the county seats of their respective counties and had a combined population of 39,000, including suburban areas, in 1970. Marysville and Yuba City are service centers for ranchers and residents of Beale AFB located about 12 miles to the east. Linda-Olivehurst, an

unincorporated area of over 15,000 residents 4 miles southeast of Marysville, has recently undergone rapid growth related to Beale AFB.

A major portion of the social pattern within the project area is associated with the Marysville-Yuba City urban center and the towns of Smartville, Browns Valley, and Loma Rica, and many of the employment, educational, and social activities of the project area residents are conducted at these locations. Many residents of the area are descendants of gold miners and have relatives and friends throughout Yuba, Sutter, and Butte Counties. The project area has few sources of employment, other than farming, and a large percentage of the labor force commutes to work in the Marysville-Yuba City area. There are no churches in the project area, but there are two in Smartville. Children in the project area attend elementary schools in Smartville (grades K-8), Browns Valley (grades 5-8), or Loma Rica (grades K-4) and high school in Marysville.

a. Population. - The rapid population growth rate which occurred in California over the past six decades had a significant impact on population growth both in the Sacramento basin and in Yuba, Sutter, and Butte Counties. As shown in the next tabulation, the three-county population increased from about 60,000 in 1930 to almost 189,000 in 1970. This is a 215 percent increase during a 40-year period, which corresponds to an annual compound growth rate of 2.9 percent. During the same period, the historical growth rate for California was slightly higher, at 3.2 percent

per year. When comparing the population trends of the individual counties, Yuba County population increased 32 percent for the 1960-1970 period, a much greater increase than the three-county average.

HISTORICAL POPULATION
(as of 1 April)

	1930	1940	1950	1960	1970
Yuba County	11,331	17,034	24,420	33,859	44,736
Sutter County	14,618	18,680	26,239	33,380	41,935
Butte County	34,093	42,840	64,930	82,030	101,969
Total	60,042	78,554	115,589	149,269	188,640

Source: California Statistical Abstract.

In the three-county area, as well as in California and the United States, there has been a general increase in urban population, as shown in the next tabulation. The data indicate a substantial decrease in non-farm population for Yuba and Butte Counties, with only a slight decrease for Sutter County. The large Yuba County decrease is the result of the growth of the communities of Linda and Olivehurst.

County		Population	Percent rural non-farm	Percent rural farm	Percent urban
Yuba:	1960	33,859	32.4%	7.0%	60.6%
	1970	44,736	24.5%	4.4%	71.1%
Sutter:	1960	33,380	37.8%	18.2%	44.0%
	1970	41,935	35.7%	11.7%	52.6%
Butte:	1960	82,030	39.7%	7.3%	53.0%
	1970	101,969	31.5%	4.8%	63.7%
California:	1960	15,717,204	11.5%	2.1%	86.4%
	1970	19,957,304	7.9%	1.2%	90.9%

Source: Census of Population, General Social and Economic Characteristics.

The population of urban areas in the Yuba-Feather Rivers flood plain is shown in the next tabulation. The latest census data indicate the population of the cities of Marysville, Yuba City, Linda and Olivehurst is 39,170, and the population of Biggs, Gridley, Live Oak and Oroville is 14,787. (It should be noted that only about one-fourth of Oroville is in the flood plain, but the population shown is for the entire city.) The 68 percent growth in Olivehurst during the 1960-70 period resulted primarily from expansion at Beale AFB. Currently the population of the flood plain is estimated to total 92,600, or about 40 percent of the three-county population. Approximately 21 percent (19,600) of the population in the flood plain is rural, while the remainder (73,000) resides in either the Marysville-Yuba City urban area or other small towns.

Area	1950	1960	1970
Marysville	7,826	9,553	9,353
Yuba City	7,861	11,507	13,986
Linda	N.A.	6,129	7,731
Olivehurst	3,588	4,835	8,100
Subtotal	19,275	32,087	39,170
Biggs	760	840	1,115
Gridley	3,054	3,343	3,334
Live Oak	1,770	2,276	2,602
Oroville	5,387	6,115	7,536
Subtotal	10,971	12,574	14,787
Total	30,246	44,661	53,957

Source: Census of Population, General Population Characteristics; 1950 and 1960 Biggs population figures derived from Butte County General Plan 1973.

b. <u>Population characteristics</u>. - The general population characteristics of the study area are similar to those of the State, as shown in the next tabulation. The age distribution of the population reflects a slightly greater percent of persons 65 and older in the Yuba, Sutter and Butte Counties area than for the State as a whole.

POPULATION CHARACTERISTICS OF THE THREE-COUNTY AREA AND CALIFORNIA

Characteristics	Yuba 1960	Yuba 1970	Sutter 1960	Sutter 1970	Butte 1960	Butte 1970	Yuba, Sutter, and Butte County Total 1960	Yuba, Sutter, and Butte County Total 1970	California 1960	California 1970
Population										
Number	33,859	44,736	33,380	41,935	82,030	101,969	149,269	188,640	15,717,204	19,957,715
Percent increase (for decade)	39%	32%	27%	26%	26%	24%	29%	26%	48%	27%
Age distribution										
Under 20	41%	42%	41%	40%	36%	34%	38%	37%	37%	37%
20-64	51%	52%	51%	52%	50%	52%	51%	52%	54%	54%
65 or older	8%	6%	8%	8%	14%	14%	11%	11%	9%	9%
21 yrs & over	57%	56%	58%	59%	62%	64%	60%	61%	61%	61%
Median school yrs. completed (25 yrs. & older)	10.8	12.2	11.2	2.2	11.4	12.2	11.2	12.2	12.1	12.4
Households										
Number	9,855	13,074	9,967	13,159	27,303	34,910	47,125	61,143	4,981,000	6,573,861
Percent increase (for decade)	38%	33%	27%	32%	28%	21%	30%	30%	49%	32%
Percent pop. in households	98%	96%	98%	99%	98%	96%	98%	97%	97%	97%
Persons per household	3.28	3.27	3.30	3.16	2.95	2.82	3.09	2.99	3.05	2.95
Household relationship										
Head of household	29%	31%	30%	32%	34%	35%	32%	34%	33%	34%
Wife of head	24%	23%	24%	24%	24%	24%	24%	24%	23%	22%
Other relative of head	45%	44	44%	43%	40%	37%	42%	39%	42%	42%
Nonrelative of head	2%	2%	2%	1%	2%	4%	2%	3%	2%	2%
Population in group quarters										
Number	1,519	1,964	493	355	1,578	3,664	3,590	5,983	509,800	578,936
Percent of total population	4%	4%	2%	1%	2%	4%	2%	3%	3%	3%
Employment										
Non-worker/worker 1/	1.55	1.77	1.70	1.50	1.74	1.86	1.69		1.44	1.37
Percent in mfg. industry	12%	11%	8%	8%	12%	10%	11%	10%	24%	22%
Percent in white-collar occup. 2/	36%	45%	38%	47%	43%	50%	40%	48%	47%	54%
Income										
Median for families	$5,031	$7,167	$5,670	$9,178	$5,408	$7,995				
Per capita income of persons	$2,778	$4,400	$2,460	$3,421	$2,085	$3,176	$2,325	$3,520	$2,761	$4,508
Median for families and unrelated individuals	$4,105	$5,773	$4,889	$8,033	$4,346	$5,028				

Source: Derived from 1970 Census of Population, General Population Characteristics, General Social and Economic Characteristics for California, and California Statistical Abstract.

1/ Ratio of persons not in the labor force (including children under 16) to labor force.

2/ Professional, managerial (except farm), clerical, and sales.

Population characteristics of Marysville, Yuba City, Linda, and Olivehurst are shown in the next tabulation. Many older and retired persons live in the Marysville-Yuba City general area, thus giving rise to a higher proportion of the aged, and local planners expect this trend to continue. Approximately half of the residents of Linda and Olivehurst are military personnel at Beale AFB and their families, and Linda and Olivehurst have relatively few persons 65 and older.

The communities of Linda and Olivehurst have many of the characteristics of a low income area, with large average household size, high unemployment rates, and a low level of education. The primary sectors of civilian employment are those of construction and manufacturing. In Marysville-Yuba City the proportion of white collar employment is much higher than in Linda and Olivehurst, with the primary industries being wholesale and retail trade, public administration and professional services.

Population Characteristics

Characteristics	Marysville	Yuba City	Linda	Olivehurst	Total
Population					
Number	9,353	13,986	7,731	8,100	39,170
Percent increase (for 1960-70)	-2%	22%	26%	67%	33%
Age distribution					
Under 20	34%	36%	42%	46%	39%
20-64	54%	54%	52%	48%	52%
65 or older	12%	10%	6%	6%	9%
21 yrs & over	65%	62%	51%	49%	58%
Median school yrs. completed (25 yrs. & older)	12.4	12.3	11.7	10.5	11.8
Households					
Number	3,384	4,971	2,436	2,284	13,075
Percent increase (for 1960-70)	4%	35%	36%	70%	39%
Percent pop. in households	98%	99%	98%	99%	99%
Persons per household	2.71	2.79	3.11	3.52	2.96
Household relationship					
Head of household	37%	36%	32%	28%	34%
Wife of head	23%	24%	23%	22%	23%
Other relative of head	38%	38%	43%	49%	41%
Nonrelative of head	2%	2%	2%	1%	2%
Population in group quarters					
Non-worker/worker 1/	189	140	167	52	548
Percent of total population	2%	1%	2%	1%	1%
Employment					
Non-worker/worker 1/	1.39	1.36	1.71	2.69	1.68
Percent in mfg. industry	6%	8%	14%	16%	10%
Percent in white-collar occup. 2/	N.A.	56%	N.A.	N.A.	N.A.
Income					
Median for families	$8,746	$8,877	$5,965	$6,611	-
Per capita income of persons	$3,188	$3,139	$2,153	$1,961	$2,714
Median for families and unrelated individuals	$6,379	$7,620	$2,711	$2,392	-

Source: Derived from 1970 Census of Population, General Population Characteristics, General Social and Economic Characteristics for California, and California Statistical Abstract.

1/ Ratio of persons not in the labor force (including children under 16) to labor force.

2/ Professional, managerial (except farm), clerical, and sales.

N.A. - Not available.

c. Households and housing. - The population growth trend in the three-county area is reflected in growth of households, i.e., family units. Between the years 1950 and 1970, households in California increased from 3.3 million to 6.57 million, at an average rate of 3.5 percent per year. Forces affecting growth throughout the State also had an impact on the three-county area, with the number of households in the local area increasing since 1960 at nearly the same rate as the State as a whole.

Strongly correlated to the number of households is the number of housing units. (A household is a family unit; a housing unit is a physical structure.) The same trends perceived for households also hold true for housing units. The increase in housing units in Marysville between 1960 and 1970 was 4.4 percent, as shown in the next tabulation, about the same as the increase in households for the same period. However, in the 1960-70 period the population in Marysville declined 2.1 percent, in contrast to the 4.4 percent increase in number of housing units, with the number of persons per housing unit decreasing from 2.79 in 1960 to 2.62 in 1970. This trend is in agreement with that of the Sacramento Basin, the State and the nation. Consequently, even if a population is static or increasing slowly, the associated damageable property (housing units and their contents) will increase at a greater rate if there is a declining trend in the number of persons per housing unit.

		1950	1960	1970
California	Housing units	3,590,660	5,465,870	6,996,990
	Pers./unit	2.95	2.88	2.85
Yuba County	Housing units	7,392	11,113	14,202
	Pers./unit	3.09	3.05	3.15
Sutter County	Housing units	8,440	11,077	14,102
	Pers./unit	3.11	3.01	2.97
Butte County	Housing units	21,596	31,494	38,110
	Pers./unit	2.99	2.69	2.68
Marysville	Housing units	2,594	3,425	3,575
	Pers./unit	3.02	2.79	2.62
Yuba City	Housing units	2,748	3,963	5,256
	Pers./unit	2.86	2.90	2.66

Source: Census of Housing, General Housing Characteristics.

The value distribution of owner and renter occupied housing is shown in the next tabulation, together with data on vacancy rates. Data on median value indicate the value of housing in Linda-Olivehurst is substantially less than in Marysville-Yuba City, and the Linda-Olivehurst area has very few homes valued above $20,000. The median rent for renter occupied housing ranges from $79 in Olivehurst to $98 in Yuba City.

The rental vacancy rate for California is 5.6 percent and 5.2 percent for Sutter County, as compared to 4.9 percent for Yuba City, and this latter rate represents a tighter market than in the rest of the area. The rental vacancy rate in Marysville is aligned with the low income Linda-Olivehurst area due to the physical aspects of Marysville.

Marysville is an older, more developed, mature city and is built up to a higher degree. Growth in the city is now confined by the levees that surround it. Apparently new growth is taking place elsewhere, as evidenced in Yuba City by higher rental rates, a greater number of housing units, and a faster rate of growth of retail sales.

HOUSING CHARACTERISTICS AND VALUE OF HOUSING UNITS, 1970

	Linda	Olivehurst	Marysville	Yuba City
	(Owner Occupied) 1/			
Less than $9,999	34%	42%	7%	13%
$10,000 to $14,999	36%	34%	32%	29%
$15,000 to $19,999	22%	20%	34%	31%
$20,000 or more	8%	4%	27%	27%
Total number	(863)	(1,209)	(1,594)	(2,382)
Median value	$12,200	$11,100	$16,500	$16,200
	Contract Rent, 1970 (Renter Occupied) 2/			
Less than $59	11%	18%	17%	10%
$60 to $79	26%	32%	27%	21%
$80 to $99	25%	20%	23%	20%
$100 or more	35%	25%	31%	47%
No cash rent	3%	5%	2%	2%
Total number	(1,327)	(821)	(1,668)	(2,408)
Median rent	$88	$79	$83	$98
	Vacancy Rates, 1970			
Home owner vacancy rate	0.8%	4.8%	1.3%	1.5%
Rental vacancy rate	15.2%	10.7%	8.4%	4.9%

Counties

	Yuba	Sutter	Butte	California
Home owner vacancy rate	2.1%	1.1%	2.0%	1.4%
Rental vacancy rate	8.7%	5.2%	8.4%	5.6%

Source: Census of Housing.

1/ Limited to one-family homes on less than 10 acres and no business on property.

2/ Excludes one-family homes on 10 acres or more.

d. Racial characteristics. - In 1970 Yuba City had the highest percentage of whites (95.6 percent), and Marysville had the highest percentage of Asian Americans (4.6 percent) in the four city urban complex.

	Marysville	Yuba City	Linda	Olivehurst	Total	3-County Total
Total Population	9,353	13,986	7,731	8,100	39,170	188,640
Whites	88.1%	95.6%	90.5%	94.2%	92.5%	94.8%
Blacks	5.0%	0.6%	4.7%	4.0%	3.1%	2.1%
American Indian	0.6%	0.5%	0.3%	0.4%	0.5%	0.7%
Asian American	4.6%	1.6%	1.0%	0.6%	2.0%	1.2%
All Others	1.6%	1.8%	3.5%	0.8%	1.9%	1.2%

Source: Census of Population, General Population Characteristics.

In the total flood plain area, about 8 percent of the population speak Spanish or is of Spanish surname.

e. Educational characteristics. - Information follows on relative educational levels for the four cities and the Yuba-Sutter-Butte Counties area as of 1970. The median level of education is slightly below the California State median of 12.4 years.

Education (Highest Level)	Marysville	Yuba City	Linda	Olivehurst	3-County Total
Total, 25 years and older	5,299	7,401	3,332	3,725	100,702
No school years completed	1.3%	0.9%	2.2%	1.0%	1.1%
Elementary	19.7%	19.2%	27.7%	38.5%	22.7%
High School	48.5%	53.8%	55.0%	48.3%	51.0%
College	30.5%	26.1%	15.1%	12.2%	25.2%
Median	12.4 yrs.	12.3 yrs.	11.7 yrs.	10.5 yrs.	12.2 yrs.

Source: Census of Population, General Social and Economic Characteristics.

Historical data on school enrollments in the study area are shown in the next tabulation. An examination of demographic factors and the consequent implications for school enrollments are key elements in understanding the historical and future course of school enrollments. Recently, there has been a decline in school enrollments nationally due to a decrease in the fertility rate, even though population has been increasing. Statistics for California reveal a similar trend, as do the statistics for Yuba and Sutter Counties. For Yuba City Unified School District, kindergarten through eighth grade (K-8) enrollment has decreased 343 since 1968, while high school enrollment increased by 239 in the same period, giving a decline in total enrollment of 104. This decline, except for one year, has been steady. On the other hand, total enrollment for Marysville Joint Unified School District has been erratic since 1967 due to construction of New Bullards Bar Dam and unstable economic conditions. The K-5 grades show decreases for three years, an increase for one year with one year essentially stable, while high school grades show an increase for four of five years. Total enrollment since 1967 has increased only slightly.

Marysville Joint Unified School District

Year	K-5	% Change	6-8	% Change	9-12	% Change	Total	% Change
1967	4616	-	1958	-	2132	-	8706	-
1968	4718	2.4	1999	1.7	2180	2.3	8897	2.2
1969	4447	-5.7	1929	-3.6	2188	0.4	8564	-3.8
1970	4453	0.1	2023	4.9	2281	4.3	8757	2.3
1971	4317	-3.1	2039	0.8	2266	-0.7	8622	-1.5
1972	4295	-0.5	2105	3.2	2314	2.1	8714	1.1

Yuba City Unified School District

Year	K-8	% Change	9-12	% Change	Total	% Change
1966	5455	-	2213	-	7668	-
1967	5464	0.2	2264	2.3	7728	0.8
1968	5639	3.2	2256	-0.4	7895	2.2
1969	5501	-2.4	2351	4.2	7852	-0.5
1970	5495	-0.1	2391	1.7	7886	0.4
1971	5394	-1.8	2449	2.4	7843	-0.5
1972	5296	-1.8	2495	1.9	7791	-0.7

Source: Master Plan Study for Yuba City Unified School District, June 4, 1973; Marysville Joint Unified School District Facilities Plan, 1972-82.

At present, crowding is not generally a problem in grades K-8 in the Yuba City Unified School District, but is of major concern in the high school. The Marysville Joint Unified School District presents a different picture. Systems Planning Corp. has recommended that Rose Bar and Brophy sites be completely abandoned while, by law, numerous other schools have buildings which must be abandoned soon. Overcrowding is evident in several schools, namely Ella, Yuba Gardens, Marysville High

School, and Ellis High School with potential overcrowding in the future at McKenney, Olivehurst, and Cedar Lane. The foothills area schools (six in total) are the only schools expected to experience an increase in future enrollments.

The Marysville School District lags behind other districts in the area in both educational techniques and facilities due to lack of community support, as evidenced by past failures of bond and tax elections. In the past, the expansion of Beale AFB has increased enrollments, and Federal money has been provided to the district to compensate for this impact. This money has gone for business machines, science apparatus, and other modern equipment. This source of funds will remain stable in the future or possibly decrease if the Base housing policy allows more families to move onto the Base, out of the district. Thus, the district would seem to have a continuing problem in financing new construction and in providing the proper educational atmosphere.

3. Economic setting. -

The economy of the Sacramento region has changed dramatically during the past 40 years from one based on agriculture to one relying on industry, government services, and military bases as well as agriculture. It is expected that the region's economic base will continue to shift its dependence from the local components (mining, manufacturing, and agriculture) to the government-directed components of government employment and transfer payments.(4)

Historically, Yuba County has been dominated by trade and service activities concentrated in Marysville. However, since the early 1960's, Beale AFB has become the dominant generator of personal income, accounting for more than 25 percent of the county's income.(4) The Sacramento Regional Area Planning Commission expects that during the next 30 years Yuba County's economic growth rates will be lower than those of the rest of the region. Agriculture and mining, as well as employment at Beale AFB, are expected to be relatively stable. The primary stimulus for additional economic growth is expected in manufacturing, expanding recreational facilities, and retirement complexes.(4) The county has the fifth highest percentage of families (15 percent) with incomes below the poverty level in the State.(1) Public assistance accounts for 64 percent of the Yuba County budget.(7) Yuba County's total assessed valuation is $99,812,064 for fiscal year 1976. Yuba County's total

NOTE: Numbers in parentheses refer to references cited at the end of this Appendix.

assessed valuation for fiscal year 1974 was $83,027,000, the thirteenth lowest of California's 58 counties. In fiscal year 1972, the tax rate of $4.71 per $100 assessed valuation for county services was the highest in the State. The tax rate has dropped, to $3.85 per $100 assessed valuation for fiscal year 1976.

Beale AFB contributes directly to the local economic strength as nearly 37 percent of the total Yuba County population are base personnel (military and civilian) and their dependents. More than one-half of the base-supported population of about 17,000 persons (families and singles) live off the base, occupying over 2,500 dwelling units or about 20 percent of the total units in Yuba County. The true effect of the base is locally felt by its annual payroll of $41 million in 1967 which was nearly as large as the 1965 total salaries and wages in Yuba County as reported on income tax returns.

Sutter County is primarily an agricultural county with 11.7 percent of the county in rural farms, which is nearly 10 times the average for the State of California. However, professional and related services and trade industries are the two areas employing the greatest number of people, and agriculture, forestry, and fisheries is the third highest area. It is expected that land on the fringes of Yuba City and Live Oak, which contain some of the best soils in Sutter County, will remain in their present state as productive orchards and valuable agricultural crop areas. For fiscal year 1976, Sutter County's total assessed valuation is

$189,894,930, and the tax rate is $2.75 per $100 assessed valuation for county services. Sutter County's total assessed valuation is twenty-first from the lowest of California's 58 counties. Sutter County's tax rate is lower than the State counties' average of $2.89, and Yuba County's is considerably higher than the average.(5)

The urban center in the vicinity of the Marysville Lake project is the Marysville-Yuba City area, a commercial and urban complex separated by the Feather River. Marysville is located at the junction of the Feather and Yuba Rivers and is bounded, by levees on all sides, leaving little room for expansion. Consequently, much of the new growth, both in population and in commercial activity, is taking place on the other (western) side of the Feather River in Yuba City.

a. Labor force and employment. - In the period 1960-1970 there was a modest increase in civilian employment in the area. Beale AFB is the largest single employer in the area, with a current labor force of about 6,600 employees, of whom 600 are civilian. Data on employment status and on employment by industry division for Yuba, Sutter, and Butte Counties in 1970 are presented in the following tabulation. The services and trade industries account for the greatest number of employed.

	Yuba	Sutter	Butte	Total
Employment Status				
Total labor force	15,923	16,039	35,258	67,220
Civilian labor force	11,122	15,519	35,199	61,840
Civilian employment	10,000	14,201	31,737	55,939
Percent unemployed 1/	10.1%	8.5%	9.8%	9.5%
Industry Division of the Employed				
Agriculture, forestry and fisheries	1,132	2,681	2,899	6,712
Construction	930	1,247	1,892	4,069
Manufacturing	1,058	1,064	3,053	5,175
Transportation	244	482	715	1,441
Communications, utilities, and sanitary services	248	631	1,522	2,601
Wholesale and retail trade	2,146	2,959	7,681	12,786
Finance, insurance, business and repair services	662	941	2,336	3,939
Professional and related services	2,514	3,295	10,034	15,843
Public administration	842	886	1,523	3,251
Other industries (mining)	25	15	82	122

Source: Census of Population, General Social and Economic Characteristics.
1/ Percent of civilian labor force.

The next tabulation presents data on employment and industry division of civilian employment for the urban areas. The data indicate that unemployment rates for Linda and Olivehurst are very high. Historically, the unemployment rates in Linda and Olivehurst have exceeded those of the Marysville urban area, and at present it is evident that the two communities lack sufficient employment opportunities to materially reduce the existing high levels. Median family income in Yuba County in 1970 was $7,167, one of the lowest in the State.

	Marysville	Yuba City	Linda	Olivehurst	Total
Employment Status					
Total labor force	3,811	5,865	2,729	2,192	14,597
Civilian labor force	3,551	5,465	2,026	1,803	12,845
Civilian employment	3,339	4,910	1,722	1,597	11,568
Percent unemployed 1/	6.0%	10.2%	15.0%	11.4%	10.0%
Industry Division of the Employed					
Construction	278	439	188	194	1,099
Manufacturing	203	298	238	251	1,090
Transportation	49	145	36	56	285
Communications, utilities, and sanitary services	184	209	36	67	496
Wholesale and retail trade	830	1,248	381	326	2,785
Finance, insurance, business and repair services	237	376	160	70	843
Professional and related services	776	1,104	282	219	2,381
Public administration	334	392	136	158	1,020
Other industries	448	599	266	256	1,569

Source: Census of Population, General Social and Economic Characteristics.
1/ Percent of civilian labor force.

The next tabulation presents information on the percent of population employed outside the county of residence. The data indicate that over 40 percent of the employed people living in Yuba City work outside their county, implying that they work primarily in the Marysville area of Yuba County. This percentage is more than four times greater than that of California and is exceeded only by such areas as Daly City. The high percent of movement across county lines for Yuba City also

applies to Sutter County, where over one-third of the employed population works outside of the county. This movement occurs to a greatly diminished degree in Yuba County, with 16.2 percent of the labor force traveling to a different county for employment. A major cause for persons in Yuba City and Sutter County crossing county lines for employment is Beale AFB.

Year	Sutter County	Yuba City	Yuba County	Butte County	California
1960	31.9	42.7	13.4	6.4	7.3
1970	36.1	43.3	16.2	7.3	10.5

Source: Census of Population, General Social and Economic Characteristics.

b. Personal income. - A historical accounting of total personal income is presented in the next tabulation. The data indicate that total income for the three-county area has increased substantially, from $190.3 million in 1950 to $728.2 million in 1971. Adjusting these numbers to a comparable base (1967 dollars), the rate of increase is 3.9 percent per year.

County	1950	1960	1970	1971
Yuba	$ 43.3	$ 92.9	$193.4	$206.4
Sutter	53.3	82.8	143.3	160.5
Butte	93.7	172.9	320.4	361.3
Total	$190.3	$348.6	$657.1	$728.2

Source: California Statistical Abstract.

Total personal income in 1970 by major sources for the three counties is listed in the next tabulation in millions.

Source	County: Yuba	County: Sutter	County: Butte	3-County Total	Percent Distribution of 3-County Total
Wages and salaries	$135.9	$ 68.8	$156.2	$360.9	54.9%
Other labor income	3.6	2.8	7.3	13.8	2.1%
Proprietor's income	15.2	37.8	44.2	97.2	14.8%
Property income	14.2	17.2	49.7	81.1	12.3%
Transfer payments	24.6	16.6	63.0	104.2	15.9%
Total	$193.4	$143.3	$320.4	$657.1	100.0%

Source: California Statistical Abstract.

Per capita income, shown in the next tabulation, has also increased over the 1950-1970 period, but has not kept pace with that of the State. In constant dollars, per capita income for the three counties has always been below the average for the State, partially due to agricultural activity. Per capita income for those living and working in rural America has always been below that of their urban counterparts. The compound growth rates for 1950-1970 are near that of California, except for Sutter County; here again, Sutter County is the most agriculturally active.

PER CAPITA INCOME (in constant 1967 dollars)

Year	Yuba	Sutter	Butte	California
1950	$2,459	$2,817	$2,002	$2,571
1960	$3,094	$2,796	$2,377	$3,081
1970	$3,718	$2,938	$2,702	$3,827
Compound growth rate for				
1950-1970	2.0%	0.2%	1.4%	2.0%

Source: California Statistical Abstract.

A major indicator of the prosperity of an area is the family income distribution, shown in the next tabulation for 1969. The proportion of families having an income below $10,000 is approximately 55 percent in Sutter County and 70 percent in Yuba County, as compared to 45 percent for the State. The disparity between urban areas is even wider. In Marysville-Yuba City about 55 percent of the families earn below $10,000, while in Linda-Olivehurst about 80 percent earn below $10,000. The percentage of families with income less than poverty level is about the same in Yuba City as in California as a whole; however, the Linda-Olivehurst area has an average of 18.7 percent of all families below the poverty income level, due primarily to large numbers of welfare recipients living there.

	Linda	Olivehurst	Marysville	Yuba City
All families	2,006	2,034	2,438	3,851
Less than $1,999	8%	7%	9%	4%
$2,000 to $4,999	32%	27%	17%	19%
$5,000 to $7,999	28%	28%	18%	20%
$8,000 to $9,999	13%	17%	11%	14%
$10,000 to $14,999	12%	15%	25%	26%
$15,000 to $49,000	7%	6%	20%	17%
$50,000 or more	-	1/	1/	1/
Income less than poverty level	18.9%	18.5%	14.2%	7.7%

1/ Less than 1%.

	Yuba	Sutter	Butte	Total	California
All families	10,896	11,020	26,398	48,314	5,001,255
Less than $1,999	7.5%	4.5%	6.7%	6.4%	4.6%
$2,000 to $4,999	21.4%	17.2%	22.6%	21.2%	12.3%
$5,000 to $7,999	28.6%	19.7%	20.6%	22.2%	16.0%
$8,000 to $9,999	12.7%	13.2%	12.8%	12.8%	12.5%
$10,000 to $14,999	18.3%	25.4%	22.5%	22.2%	28.0%
$15,000 to $49,000	11.4%	19.3%	14.5%	14.9%	25.7%
$50,000 or more	0.1%	0.7%	0.3%	0.3%	0.9%
Income less than poverty level	15.1%	9.0%	12.1%	12.1%	8.4%

Source: Census of Population, General Social and Economic Characteristics.

c. Commercial. - Data on retail sales is presented in the next tabulation. For years, Marysville has been the commercial and historical trading center; however, it appears that Marysville is losing its position as the hub of commercial activity, partially due to the fact that there is little room for expansion within the Marysville levees.

	County			Marysville	Yuba City
	Yuba	Sutter	Butte		
1954					
Number of retail establishments	425	250	884	329	146
Sales (current $1,000 dollars)	$48,263	$23,489	$ 87,158	$43,513	$15,424
1967					
Number of retail establishments	444	388	1,003	299	240
Sales (current $1,000 dollars)	$63,677	$70,880	$167,886	$53,023	$47,954
Sales in Constant ($1,000) 1967 Dollars					
1954	$59,991	$29,197	$108,294	$54,087	$19,172
1967	$63,677	$70,880	$167,886	$53,023	$47,954
Compound growth rate for 1954-67	0.4%	7.0%	3.4%	-0.1%	7.3%

Source: U. S. Census of Business, 1954-1967.

Although the present population of Yuba City is 50 percent greater than that of Marysville, the city of Marysville has the predominant commercial position; however, the center of trade is shifting to Yuba City. In constant dollar terms, the compound growth rate for the 1954-1967 period for retail sales was -0.1 percent for Marysville and 7.3 percent for Yuba City.

The next tabulation, which presents the market value of State and county-assessed property, also illustrates the shifting trade base. In all, this seems to indicate that the general economy of Yuba City is experiencing growth.

MARKET VALUE OF STATE AND COUNTY ASSESSED PROPERTY
(In thousands of current dollars)

(Net of exemptions)

Year	County: Yuba	County: Sutter	County: Butte	Marysville	Yuba City
1965	$316,534	$573,826	$1,150,000	$ 98,426	$106,129
1968	342,898	683,491	1,150,885	96,589	121,540
1970	336,947	687,578	1,177,488	98,660	128,435
1972	381,797	703,932	1,321,722	106,806	150,421
1976	530,942	1,023,068	2,297,135	135,823	239,048

Source: California State Board of Equalization, Annual Report.

d. Agriculture. - Agriculture is the primary industry of the economy of the three-county region. The percent rural farm population of the three-county area is over five times that of the State's portion of 1.2 percent. Specifically, Sutter County (11.7 percent rural farm) is nearly 10 times the State-wide average. Substantiating the prominence of agriculture in Yuba, Sutter, and Butte Counties is the relative intensity of agricultural production. Of all agricultural land, the portion irrigated in the three counties is 38.2 percent, compared to the State average of 20.3 percent, as shown in the next tabulation. In comparable terms, the three-county average of agricultural acres that are cropland is 20 percent higher than the State-wide proportion.

	County			3-County	
	Yuba	Sutter	Butte	Total	California
Total agricultural acres	228,053	389,014	551,254	1,168,321	35,722,348
Total irrigated acres 1/	67,259	201,138	177,490	445,887	7,240,131
Total cropland acres 1/	92,125	266,687	255,926	614,738	11,245,140
% irrigated	29.5%	51.7%	32.2%	38.2%	20.3%
% cropland	40.4%	68.6%	46.5%	52.6%	31.5%

Source: 1969 Census of Agriculture.
1/ These are overlapping categories and should be considered independently.

The three-county region contains a variety of highly developed irrigated crops. Orchards, truck, and intensive field crops are grown near the rivers on the deep alluvial soils. Farther from the rivers in areas of heavier, impervious types of soils, there is a considerable amount of rice. Most of the remaining undeveloped land is suitable for irrigated pasture, barley, and other shallow rooted crops.

Since the relative intensity of farming in this area is substantially greater than the State-wide average, it follows that the average value per acre of agricultural land should also be greater than the State-wide average, as shown in the next tabulation for 1969:

	County			3-county	
	Yuba	Sutter	Butte	Total	Calif.
Farms reporting	519	1,411	1,844	3,774	-
Acres	228,053	389,014	551,254	1,168,321	-
Acres/farm	439.4	275.7	298.9	309.6	458.7
Value of land and buildings					
Average per farm	$230,977	$206,088	$168,334	$191,064	$217,730
Average per acre	526	748	563	617	475
Market value of all agric. products sold					
Average per farm	$ 55,608	$ 41,610	$ 28,139	$ 36,953	$ 50,125

Source: 1969 Census of Agriculture.

The average market value of agricultural products per acre (products sold in 1969) is $120 for the counties, which is 10 percent higher than the average for the State of $109 per acre. Although the economy of the three-county region centers on agricultural-related activities, there are other industries, such as light manufacturing in the Marysville-Yuba City area and lumbering in the mountain regions. Reasons for the prominence of agriculture are the rich alluvial soils, ideal climate and available irrigable water. In these alluvial soils the most significant crop is rice. In 1973, rice accounted for 33 percent of the total value of all crops sold, an increase from 23 percent of the total value 10 years ago. Physically, the flood plain itself is probably most similar to Sutter County.

The total farm value of agricultural products for 1962, 1968, 1970 and 1973 is listed in the next tabulation. Particularly noteworthy is the surge in value between 1970 to 1973, reflecting increased worldwide demand and inflation. With agriculture being the prime concern of the three-county region, the county planners have recommended exclusive agricultural zoning. The planning commissions hope to keep the bulk of the population and urban development concentrated, rather than dispersed, because people tend to live and work in areas of soils most suitable for cultivation. In short, the planners' objective is to direct urban growth away from the most economically productive soils.

TOTAL FARM VALUE OF AGRICULTURAL PRODUCTS
(In thousands of current dollars)

County	1962	1968	1970	1973
Yuba	$ 20,320	$ 25,216	$ 30,043	$ 47,477
Sutter	57,837	80,266	77,238	159,204
Butte	48,438	64,958	68,802	139,707
Total	$126,595	$170,440	$176,083	$346,388

Source: 1962, 1968, 1970 and 1973 Yuba, Sutter and Butte County Agricultural Crop Reports.

e. Natural resources. - There are several major natural resources in the area of economic importance, primarily timber, gravel and natural gas.

In the flood plain and in Sutter County, there is no lumbering activity, but tree harvesting takes place on a large scale in the foothills and mountain regions. Timber activity in the Yuba and Butte County region has declined in the past two decades, but will continue to play a significant economic role.

There are four sand and gravel operations on the Yuba River that have supplied construction materials and rock for riprap. There are an estimated 1,400 million tons of gravel in the form of mine tailings readily available for excavation downstream of the project, and the sand and gravel companies are removing a relatively insignificant amount of tailings. Active gold mining in the project vicinity ended in 1968 when Yuba Goldfields, Inc. ceased operation; however, the company resumed limited operations in 1975, but operations ceased again in 1976.

The potential of the natural gas fields around the Sutter Buttes has been developed since 1950. Historical data on quantity and value of gas production are presented in the next tabulation.

NATURAL GAS

Quantity: million cubic feet — Value: $1,000

County	1960		1965		1971	
	quant.	value	quant.	value	quant.	value
Yuba	-	-	-	-	-	-
Sutter	2,183	$ 583	44,325	$13,120	37,566	$11,777
Butte	11,721	$3,130	9,427	$ 2,357	10,340	$ 3,236

Source: California Statistical Abstract.

4. Utilities and services. -

Yuba County services are shown graphically on Figure K-3 and are discussed briefly in the following paragraphs.

a. Transportation. - County roads in the project area are listed in the next tabulation; most are two lanes wide and paved.

Yuba County Roads	Road Number	Nevada County Roads	Road Number
Bald Mountain Road	219	Pleasant Valley Road	404 AA1
Peoria Road	9		
Hammonton-Smartville Road	36		
Timbuctoo Road	259		
Scott-Forbes Road	222		
Township Road	221		
Dolan Harding Road	220		
Sicard Flat Road	223		
Smartville Road	19		
Diggins Road	261		
O'Brien Road	245		
Blue Gravel Road	1025		

In addition to county roads, the project area is served by State Highway 20, a major east-west connector between the coast near Fort Bragg and Interstate 80 near Immigrant Gap. In Yuba and Nevada Counties, Highway 20 is a main connector between the Marysville-Yuba City area and the Nevada City-Grass Valley area. Also, Highway 20 to Marysville Road and thence north to State Highway 49 serves as a main arterial between Marysville and northeast Yuba County. The main north-south system consists of State Highways 99 and 70. State Highways 113 and 65, both from the south, terminate in Yuba City and Olivehurst, respectively.

The area is served by three railroads: the Southern Pacific, Sacramento Northern, and Western Pacific. All three provide daily freight service to Marysville-Yuba City, with additional service to the industrial park in Olivehurst.

The project area is within 15 miles of the Yuba County Airport, as shown on Figure K-3. Air West provides the only regularly scheduled air service to the Yuba County Airport, which has ground facilities and provides charter flights. The closest major airport with regularly scheduled flights is Sacramento Metropolitan Airport, 40 miles south. Beale AFB is 6 miles from the project area.

b. Liquid and solid waste. - Although most of Yuba County's liquid waste is processed by septic tank systems, the major population concentrations are in the following sewage treatment districts:

(1) City of Marysville

(2) Olivehurst Public Utility District

(3) Linda Water District

(4) City of Wheatland

The Sutter-Yuba Health Department is responsible for design and development of the treatment facilities and for health safety inspection. The Marysville treatment plant services areas primarily within the city limits. Its oxidation and evaporation ponds are on the riverbed and flood once or twice in a decade. Because the effluent contained in the ponds has undergone secondary activated sludge treatment, the adverse effects of this flooding on water quality are considered minor.(6)

Prior to 1970 Yuba County utilized eight solid waste sites(6); however, only four of these are currently used. They are the county-owned Ponderosa landfill near Brownsville, two privately-owned areas 1/2 mile north of Marysville between the levees, and a site at Beale AFB. The estimated life spans of these sites vary from 15 to 40 years at current rates of fill.(2)(3)

c. Electricity and telephone. - In Yuba County, Pacific Telephone & Telegraph provides the only telephone service, and PG&E supplies electrical power. Both utilities operate throughout the county and can extend services according to the extension rules of the Public Utilities Commission. Local offices of both companies are located in Marysville.

d. Irrigation ditches. - Seven irrigation ditches have been identified in the project area. They include the Browns Valley Ditch, Sicard Flat Ditch, Ellis Ditch, Arnold Ditch, Smith Bar Ditch, Ousley Ditch, and Farm Ditch.

e. <u>Services</u>. - Yuba County has two general hospitals in Marysville: Yuba County General Hospital with 61 beds and Rideout Hospital with 106 beds. In addition there are several convalescent hospitals.

Yuba County is divided into two police jurisdiction areas. The project site is in the northern jurisdiction, which begins north of Marysville at Sevenmile House and includes the area north and east (up to Camptonville). Three full-time deputies and a reserve force of eight volunteers patrol the northern county area.

Three fire stations serve the project area, one in Smartville, one in Loma Rica, and one in Dobbins.

5. Existing flood control measures. -

a. Existing flood control storage. - Two reservoirs affording flood protection to the Feather-Yuba basins are Oroville Reservoir located on the Feather River with a flood control capacity of 750,000 acre-feet and New Bullards Bar Reservoir, on North Yuba River, with a flood control capacity of 170,000 acre-feet.

b. Existing flood control levees. - The flood plains of the Yuba and Feather Rivers are partially protected by levees of the Sacramento River Flood Control Project authorized by the Flood Control Act of March 1917, and modified by various acts subsequently as a joint Federal-State-local interest venture. The system of levees gives partial protection to the flood plain, with the exception of the left bank of Feather River above Honcut Creek, the Jack and Simmerly Slough area, and the areas between the levees.

c. Existing nonstructural measures. -

(1) Feather River. - The Feather River from Oroville to Honcut Creek is in a designated floodway zone consisting of about 9,500 acres between the levees and adjacent to the river. Use of this area must conform to Regulations for Administration of Designated Floodways and Floodway Encroachment Lines as set forth in Title 23, California Administrative Code, Sections 45 through 95. Briefly, the regulations restrict

floodway use to open space uses, such as agricultural cropland, orchards, grazing, etc. Human habitation is not permitted unless occupied previous to the designation. In other words, nonconforming uses will phase out over time. Currently, there are nine homes and a mobile home park containing 24 trailer homes that are located near the riverside of the levee, or in the case of the trailer park, at the designated floodway extremity. Their effect on average annual flood damages over time are negligible. Historically, development of the type included in nonconforming uses has been minimal.

(2) Yuba River. - Special encroachment conditions for Lower Yuba River from Daguerre Point Dam to Highway 70 at Marysville, were adopted by the California Reclamation Board in 1972, and it is assumed that the Yuba County Board will implement these conditions through zoning. The proposal divides the area between the Yuba River levees into three zones. Area A is the channel area reasonably required to carry a flow of 150,000 cfs and restricts development to those uses noted previously for a designated floodway. Area B is the additional channel area which, with Area A, is reasonably required to carry a flow of 235,000 cfs and restricts development to that in Area A plus commercial, industrial, and housing for nonflood season labor and other uses that restrict year-round habitation. Area C consists of a strip of land of approximately 1,000 feet maximum width on the waterside toe of the project levees and all lands above the 235,000 cfs flow line. All development of Areas A and B is allowed plus public buildings, residences, mobile homes, etc.

SECTION II - DESCRIPTION OF THE FLOOD PLAIN

6. Description of flood plain area. -

The total flood plain area of the Yuba River and the Feather River below Oroville includes approximately 337,000 acres of which 35,000 acres are on the Yuba River, and the balance, 302,000 acres, are on the Feather River. Of the Feather River flood plain, about 114,000 acres are south of the mouth of the Yuba River. The flood plain area of 337,000 acres includes over 12,000 acres of urban and suburban lands and about 325,000 acres of agricultural and other uses. Approximately 86,000 acres are in orchards, 55,000 acres in rice, 18,000 in truck crops, 140,000 in less intensive agricultural pursuits, 19,000 in conservation and recreation with small areas of wasteland, and the balance consists of 7,000 acres of mine tailings. The Yuba and Feather Rivers Flood Plain has been divided into flood damage reaches, as shown on Figure K-2. The flood plain area in each reach is shown in the following tabulation, and the reaches are described in the following paragraphs.

Reach	Acres	Reach	Acres
1	10,800	8	59,500
2	20,900	9	400
3	2,100	10	41,000
4	1,500	11	12,100
5	25,900	12	69,800
6	25,900	13	65,000
7	2,100		

7. Reach 1. -

Reach 1 consists of the area within the existing Yuba River Project levees extending from the Highway 70 bridge upstream to the upper end of the project levees. While this area is subject to frequent flooding and is predominately agricultural, other uses include a golf course and clubhouse, a radio station, packing houses, warehouses, a small trailer manufacturing plant and over 225 homes. Principal crop acreages are fruits and nuts, 48 percent of the area; and irrigated and native pasture with attendant grazing, 22 percent.

8. Reach 2. -

Reach 2 includes the flood plain area from Daguerre Point Debris Dam to the eastern tip of the left bank project levee, then southwest to Highways 70 and 65. Agriculture is predominant in this reach. The principal crops are fruits and nuts, 6 percent; rice, 10 percent; field crops, 11 percent; and irrigated and dry pasture, 58 percent.

9. Reach 3. -

Reach 3 contains the city of Linda and suburbs and is located north and east of the Southern Pacific Railroad and south of the left bank of the project levee. The city of Linda is expanding at a rapid pace due to its proximity to Beale AFB, Yuba Community College, and the recently constructed major shopping center, "The Mall."

10. Reach 4. -

Reach 4 consists of Marysville and that area enclosed by the surrounding ring levee. Marysville is the county seat as well as the largest city in Yuba County. Local industries include trailer manufacturing, food processing, and some plastic manufacturing. Pacific Gas and Electric and Pacific Telephone are major employers in the city.

11. Reach 5. -

Reach 5 is on the left bank of the Feather River, extending from the Yuba to the Bear River. The flood plain is predominately agricultural, but also includes the city of Olivehurst which in the 1960-1970 decade, experienced a 67.5 percent increase in population. Expansion of the industrial park, located adjacent to nearby Yuba County Airport, contributed to the growth of Olivehurst. The principal industry in the park has been trailer manufacturing. A large manufacturing plant, Sunset Moulding, located several miles to the south, adds to employment opportunities of Oliverhurst residents. Major agricultural acreages in the reach are in peaches and nut crops, 25 percent; rice, 9 percent; and irrigated and dry pasture, 51 percent.

12. Reach 6. -

Reach 6 is on the left bank of the Feather River and extends from the mouth of the Bear River to the Sacramento River. It is bounded on

the south and southeast by the Natomas Cross Canal. Substantial acreages of the flood plain are devoted to field and grain crops, 51 percent; rice, 14 percent; and pasture, 25 percent. Included in the reach is the small town of Nicolaus.

13. Reach 7. -

Reach 7 is on the right bank of the Feather River and consists of Yuba City and vicinity. Yuba City, the county seat of Sutter County, has shown rapid population growth and retail expansion in the 1960-1970 decade. The city and suburbs have increased in population from over 23,000 in 1960 to over 31,000 in 1970. Retail expansion has occurred in strip development along Highway 20. Industries include canneries, packing plants, food mills, fruit and nut processing plants, mobile home manufacturers and other miscellaneous manufacturing.

14. Reach 8. -

Reach 8, located on the right bank of the Feather River, extends west from Yuba City to the Sutter Bypass, and south to the junction of the Sutter Bypass and Feather River. The flood plain area is almost exclusively agricultural with orchards and rice as the predominant crops, occupying over 60 percent of the flood plain.

15. Reach 9. -

Reach 9 is on the left bank of the Feather River and includes the western portion of the city of Oroville, the county seat of Butte County,

and the area immediately south of Oroville. Principal industries are lumbering, wood product manufacturing, and food processing. Oroville Reservoir is located about 5 miles notheast of Oroville.

16. Reach 10. -

Reach 10, on the left bank of the Feather River, extends generally from the city of Oroville to Marysville, outside of the area protected by the levees and the Sacramento River Flood Control Project. Included is the agricultural area from Oroville to Honcut Creek and the Jack and Simmerly Slough area near Marysville. Typically, agriculture is predominant, though less intensive than in previous reaches, as this area is about 45 percent pasture, the remainder being occupied by rice, 22 percent; orchards, 14 percent; field crops, 16 percent; and other crops, 3 percent.

17. Reach 11. -

Reach 11, on the left bank of the Feather River, consists of Reclamation District No. 10. The flood plain area is almost fully developed, with orchards occupying 78 percent of the reach. Several fruit collecting sheds are located in the area.

18. Reach 12. -

Reach 12, on the right bank of the Feather River, extends from Oroville to the Sutter County line. Orchards along the Feather River

occupy 21 percent of the reach; rice, 24 percent; pastures, 40 percent; and truck and field crops, 13 percent. Urban areas are Gridley and Biggs. Local industries, such as rice mills, prune dehydrators, and a relatively large peach cannery, are agriculturally associated.

19. Reach 13. -

Reach 13, located on the right bank of the Feather River, extends from the Sutter County line to Yuba City. Economic activity in this area centers on agriculture. Orchards utilize 36 percent of the reach; rice, 17 percent; truck and field crops, 18 percent; and the balance, 28 percent, is in pasture (domestic and native). The only city in the reach is Live Oak, whose main activities are industrially related to agriculture, i.e., feed mills, walnut processing plant, etc. Urban encroachment is evident in the southern portion of this reach near Yuba City. Exploration and production of natural gas is centered around the Sutter Buttes.

20. Nondamaging flows and levee design capacity. -

As discussed, the flood plain was divided into homogeneous flood damage reaches for the purpose of damage analysis. It should be noted that reaches 2 through 8 and 11 through 13 are protected by levees of the Sacramento River Flood Control Project. In the following tabulation, index stations, nondamaging flow, and levee design capacity is given for all reaches except reach 4.

Reach	Index Station	Nondamaging Flow (1,000 cfs)	Levee Design Capacity (1,000 cfs)
	Yuba River		
1	At mouth	40	1/
2	At mouth	120	120
3	At mouth	120	120
	Feather River		
5	Below Mouth of Yuba River	50	300
6	At mouth	60	320
7	Below mouth of Yuba River	300	300
8	Below mouth of Yuba River	50	300
9	Below Oroville Dam	50	1/
10	Below Oroville Dam	50	1/
11	Below Oroville Dam	150	210
12	Below Oroville Dam	50	210
13	Below Oroville Dam	50	210

1/ Not protected by Project levees.

Reach 4, the city of Marysville, is protected by high levees which, theoretically, are adequate to prevent flooding of the city by the Yuba River. Actually, however, the city does not have complete flood protection because of factors, other than overtopping, that may result in levee failure. Levee failure could result from excessive levee erosion during a major flood, excessive seepage, lack of maintenance, or a combination of these factors. For example, the city of Marysville could have flooded in 1955 if water pressure had not been relieved by the levee breach south of Yuba City. As it was trucks were used to weigh down storm line manhole covers to prevent water inflow within the ring levee surrounding the city.

If levees were overtopped or breached, such as occurred in the 1955 Yuba City levee failure, average depth and duration of flooding in the various reaches would be as follows:

Reach	Depth (feet)	Duration (days)
1	2	3
2	4-6	10-15
3 (Linda)	6	3-5
4 (Marysville)	26	25
5 (Olivehurst)	3-5	6-10
(rural)	16-18	25-30
6	10-14	25-30
7 (Yuba City)	7	7-10
8	10-12	35-45
9 (Oroville)	8-12	3-5
10	3-4	3-20
11	4-8	5-20
12 (Biggs)	2	2
13 (Live Oak)	5	8
(rural)	3	6-8

SECTION III - FUTURE ECONOMIC DEVELOPMENT

21. Introduction. -

Many considerations are involved in estimating the future change in economic development of the flood plain. In the case of agricultural areas, estimated gross crop returns, reflecting future crop patterns and crop yields, is believed to be a reasonable and proper basis for projecting agricultural development. For urban-suburban areas, projections of population, employment, personal income, housing units, retail sales, industrial production and other aggregate indicators (depending on the damage category) are probably the most significant factors in determining future values of damageable property. Projections of growth for future economic development generally assume that growth in the flood plain will follow the trends set by county or State growth; where the data indicate otherwise, as in the case of agriculture, projections unique to the flood plain have been developed. It is also assumed that county population growth will stabilize within 50 years of project completion and, as a result, all other aggregate indicators will also stabilize.

22. Population. -

County projections are shown in the following tabulation, derived from California State Department of Water Resources projections, dated June 1974.

Year	Yuba County	Sutter County	Butte County
1990	55,300	59,500	156,800
2000	63,200	67,800	183,800
2010	71,100	76,800	215,200
2020	78,900	86,000	249,300
2030	86,500	94,900	285,200
2040	93,800	104,300	324,200

Source: Adapted by Sacramento District Corps of Engineers from Population Projections for California Counties 1975-2020, State of California Department of Finance, June 1974.

Population projections for major urban areas in the flood plain are shown in the next tabulation. Due to the small decrease in Marysville's population between 1960 and 1970, a minimal amount of growth is projected for that city. In contrast, Yuba City's population has steadily increased historically so that the projected population nearly doubles before growth stabilizes. In both cases, urban areas are assumed to achieve full-capacity before the county does because of a general preference for open space and rural lands and a desire to escape "overcrowding". In Butte County, the fastest growing urban areas, Chico and Paradise, are located out of the flood plain.

Year	Marysville	Yuba City
1990	9,300	18,900
2000	10,100	23,000
2010	10,900	25,900
2020	10,900	26,200
2030	10,900	26,200
2040	10,900	26,200

Source: Projections by Sacramento District, Corps of Engineers

23. Employment. -

Employment opportunities are a key element in a decision to locate in a certain area, and the projected population growth for the three counties can be expected to have a multiplier-effect in increasing such opportunities. Because of a high rate of net in-migration, California's unemployment rate has been significantly above the national rate and can be expected to continue that way for the near future. However, the gap between California's unemployment rate and the national rate can be expected to decline in the future for two reasons; a recent reversal in the migration patterns in California and the decreasing importance of agricultural activities which typically have high unemployment rates associated with them. Furthermore, participation rates can be expected to increase only slightly over time because of shortened work weeks, increased participation by women of all ages, and the desire for additional income. These will be partially counterbalanced by increased delay of entrance into the job market by the college-age segment of the population. Although the importance of military personnel in the total labor market is expected to drop from 4.2 percent today to about 1.7 percent in 2020, the employment levels of Beale AFB are assumed to be approximately constant throughout the projection period. Civilian employment projections based on data contained in "1972 OBERS Projections of Regional Economic Activity in the U.S.," are presented in the next tabulation for the three-county area. The percentage of manufacturing employment is expected to decline at a higher rate than projected for the Sacramento BEA because of the higher percentage

of workers in the three-county area engaged in food and kindred products, lumber products, and furniture industries for which a decline in total employment is expected during the study period.

	1990	2000	2010	2020	2030	2040
Population	271,600	314,800	363,100	414,200	466,600	522,300
Participation Rate, %	39	40	40	41	41	41
Civilian Employment	105,920	125,920	145,240	169,820	191,310	214,140
Manufacturing Employment, %	7.90	7.39	6.97	6.63	6.36	6.12
Manufacturing Employment	8,370	9,310	10,120	11,260	12,170	13,110

Source: Participation rates and percent manufacturing employment derived from OBERS projections for Sacramento BEA by Sacramento District, Corps of Engineers

24. Personal income. -

Future income estimates for the three counties are based on per capita income projections for the Sacramento Water Resources Planning Area contained in "1972 OBERS Projections of Regional Economic Activity in the U.S." The projections for the economic areas are determined by use of the "nodal-functional" area concept which presumes that to each urban center there are attached surrounding county units in which economic activity is focused directly or indirectly on each nodal center. Each economic area combines the place of residence and place of work of employees as closely as possible, the production locus of goods and services, the number, type, and size of retail and wholesale establishments and trade

areas relative to transportation costs, as well as the general convenience of the service functions within the particular locality. The basic assumption made for disaggregating the county incomes from the OBE economic area totals is that improved transportation and communication facilities and increased mobility of workers will tend towards greater uniformity in per capita incomes for individual counties. Per capita personal income projections are shown in the next tabulation for the 1990-2040 period, based on constant 1967 dollars.

Year	Per Capita Income
1990	$ 6,190
2000	8,150
2010	10,830
2020	14,400
2030	18,160
2040	20,970

Source: Derived from OBERS projections for Sacramento Water Resources Planning Area by Sacramento District, Corps of Engineers.

25. Projected land use. -

Projected land use for the three-county area is shown in the following tabulation. The main sources for land use projections were the County General Plans and the Sacramento Regional Area Planning Commission. Since some of the counties projected land use was based on population projections made before the 1970 Census, those projections were adjusted to conform with the latest available population data. It will be noted that agricultural land use declines over the 50-year period at approximately 0.20

percent per year while forest land use declines at a rate of 0.24 percent in the same period, shifting into conservation and recreation uses as well as urban land uses.

Category	1990	2010	2040	2090
Agriculture	1,210,100	1,162,900	1,091,700	1,091,700
Forest	394,600	375,300	349,200	349,200
Conservation and Recreation	153,200	195,600	264,400	264,400
Urban 1/	57,200	78,600	102,800	102,800
Industrial	12,200	14,900	19,200	19,200
Beale AFB	23,000	23,000	23,000	23,000
Total (in acres)	1,850,300	1,850,300	1,850,300	1,850,300

Source: Projections adapted from Yuba, Sutter and Butte County General Plans and California State Depth of Water Resources, Bulletin No. 58.

1/ Urban lands include the categories of commercial and public and semi-public facilities as well as residential structures.

Projected land use in the flood plain is shown in the next tabulation. (Forest land uses as well as military land use are located out of the flood plain.)

Year	Agriculture	Conservation and: Recreation	1/ Urban	Industrial	Total (in acres)
1990	299,400	22,900	12,900	1,800	337,000
2000	295,200	24,300	15,500	2,000	337,000
2010	291,500	25,600	17,700	2,200	337,000
2020	288,600	26,600	19,400	2,400	337,000
2030	285,600	27,600	21,200	2,600	337,000
2040	282,300	28,600	23,300	2,800	337,000
2090	282,300	28,600	23,300	2,800	337,000

Source: Projections by Sacramento District, Corps of Engineers.

1/ Urban lands include the categories of commercial and public and semi-public as well as residential structures.

26. Housing. -

Increases in projected housing have been divided between major urban areas and the remaining, or mainly rural, portions of the three counties, and indices for projecting the number of future housing units are shown in the following tabulation. Housing unit growth for Marysville-Yuba City is characteristically lower than the remaining parts of the two counties because these urban areas are comparatively more developed to begin with. This also accounts for the high rate of growth of the rural areas. It is also noteworthy that there is a small amount of growth for housing units in the major urban areas even after population stabilizes. This is due to the effect of a declining ratio of persons per housing unit. The growth in housing units for the remainder of Butte County reflects increases in units, less the growth for the areas of Chico and Paradise, located out of the flood hazard area. The replacement of housing units for all damage reaches was based on a 50-year replacement cycle. Replacement ratios for individual damages reaches were based on data from the 1970 Census of Housing pertaining to the distribution of structures by year built.

Year	Remainder Butte Co.	Remainder Sutter Co.	Remainder Yuba Co.	Marysville	Yuba City
1990	1.27	1.37	1.32	1.02	1.26
2000	1.47	1.63	1.59	1.11	1.58
2010	1.74	1.91	1.87	1.18	1.89
2020	2.07	2.34	2.18	1.18	1.95
2030	2.44	2.83	2.52	1.19	2.00
2040	2.83	3.36	2.86	1.19	2.00

27. Commercial. -

It is assumed that commercial development in the flood plain will follow the same overall trend as predicted for retail trade activities. Wholesale trade is anticipated to remain of minor consequence, with virtually all commercial development related directly to retail activities. Historically, retail trade activities in the three-county area have closely paralleled population movements. Data from the California State Board of Equalization for 1960 and 1974 indicate that retail sales permits for the three counties increased at an average rate of about 2 percent per annum during this period, while the three-county population increased at an average rate of about 2.25 percent per annum.

For this analysis it is assumed that the development of retail trade establishments and, therefore, commercial development will continue to parallel population movements. Based on projections by the State of California, the population of the study area is expected to increase at an average rate of about 1.25 percent per annum between 1976 and 2040, the last year of the study period for which growth is projected. In conformance with past trends, retail trade establishments are projected to increase at a rate slightly less than for population, or about 1 percent per year, for the study area. Projections for individual damage reaches are modified by the extent of current development and by the direction of development suggested by local master plans. The replacement of commercial establishments is based on a 50-year replacement cycle, with the replacement ratios developed for residential units as described above.

28. Industrial and utilities. -

Short term historical investment in new plant and equipment data are available on a county basis, but because of the limited time span and erratic behavior of the trends, it is difficult to estimate a long term pattern for industrial growth. As a guide to assessing damageable industrial property in the flood plain, projections of future manufacturing production of food and kindred products, lumber products and furniture, and transportation equipment (excluding motor vehicles) were obtained from OBERS-72 for the Sacramento Economic Area. The projected average rate of growth for earnings in these activities is 3.45 percent per annum whole. The average rate of growth for employment is 0.88 percent. It is assumed that because of increasing productivity, increases in the number of industrial establishments will be more closely correlated with increases in employment than increases in earnings. Industrial units are, therefore, projected to increase at a rate of slightly less than one percent per annum with replacement units based on a 70-year replacement cycle. Increase in industrial units projected for individual damage reaches were based on the above assumptions, modified by the extent of existing development and local master plans.

29. Public and semipublic facilities. -

The public and semipublic category includes a wide spectrum of facilities ranging from neighborhood facilities, such as schools and

churches, to central office complexes for city, county, State or even Federal government workers. For this analysis it is assumed that population projections for the three-county area are an appropriate index for projecting increases in neighborhood facilities while 1972 OBERS projections for employment in the civilian government sector would be most appropriate for projecting increases in such centralized facilities as office buildings.

As previously discussed, the population of the three-county study area is expected to increase at an average rate of about 1.25 percent per year. Data from the 1972 OBERS report for the Sacramento BEA adapted for local conditions, indicate a similar growth rate is expected in employment in the civilian government sector. It is, therefore, assumed that an average annual growth rate of about 1.25 percent per annum is an appropriate rate for projecting increases in public facility development. Replacement units are based on a 70-year replacement cycle. Again, the above projections are modified for individual damage reaches by the extent of current development and local master plans.

30. Agriculture. -

Projections of gross returns to agriculture on all farm products in 1976 prices are summarized in the following tabulation for each damage reach with agricultural activities. In developing these projections, current cropping patterns were first derived from land use maps prepared by the California Department of Water Resources and average yields from annual reports prepared by the appropriate County Department of Agriculture.

Future cropping patterns and changes in productivity were estimated on the basis of studies of Northern California Counties prepared by the Department of Water Resources. It was assumed that cropping patterns and crop productivities would stabilize in about 50 years, or by the year 2027. The amount of land available for agricultural activities was determined from the land use projections previously described. The continued decline in agricultural acreage through 2040 combined with the stabilization of projected yields and crop distribution by 2030 results in the decline in gross returns projected for the 2030-2040 period.

Gross Returns, 1976 Prices
(In Thousands)

Reach	1990	2000	2010	2020	2030	2040
1	7,126	7,746	8,407	9,130	9,637	9,521
2	4,814	5,584	6,475	7,245	7,810	7,717
5	15,148	17,497	20,136	22,955	25,068	24,769
6	9,106	10,875	12,905	15,177	16,942	16,739
8	38,990	43,253	47,796	52,624	56,082	55,409
10	30,661	36,577	43,184	49,467	54,289	53,638
11	25,173	26,794	28,111	28,588	28,811	28,494
12	38,340	41,716	45,033	48,230	50,510	49,904
13	36,750	40,953	45,471	50,247	53,695	53,051

31. Existing and projected flood plain units. -

The number of units currently estimated to be located within the study area and projections of future units, based on the above assumptions, are summarized in the next tabulation for the following flood plain areas: the Yuba River, damage reaches 1-4; the Feather River below the mouth of the Yuba River, reaches 5-8; and the Feather River from Oroville to the mouth of the Yuba River, reaches 9-13.

Reach	Existing Conditions	1990	2000	2010	2020	2030	2040-2090
YUBA RIVER: REACHES 1-4							
Residential	6,052	7,032	8,096	9,146	10,087	11,080	11,763
Mobile Homes	632	735	839	941	1,046	1,157	1,240
Commercial	600	662	700	735	773	800	824
Industrial	60	68	73	78	81	84	86
Public & Semipublic	67	79	88	97	102	107	110
Agriculture (acres)	25,419	24,964	24,620	24,279	24,050	23,807	23,608
FEATHER RIVER below YUBA RIVER: REACHES 5-8							
Residential	13,618	17,413	21,611	25,452	27,142	28,565	29,343
Mobile Homes	772	995	1,228	1,443	1,570	1,687	1,761
Commercial	579	703	803	914	1,028	1,150	1,243
Industrial	95	110	121	131	140	149	152
Public & Semipublic	110	140	165	187	210	232	244
Agriculture (acres)	107,960	106,060	104,600	103,160	102,180	101,140	100,310
FEATHER RIVER, OROVILLE to YUBA RIVER: REACHES 9-13							
Residential	11,366	14,888	17,415	20,518	24,654	29,124	32,393
Commercial	340	411	471	537	604	675	729
Industrial	80	91	101	109	117	124	127
Public & Semipublic	69	89	106	121	135	149	157
Agriculture (acres)	185,110	181,840	179,330	176,880	175,200	173,400	171,990

32. Future property values. -

For damage and benefit analysis, existing structures are evaluated on the basis of their current market values, and new and replacement units are evaluated on the basis of 1976 construction prices and conditions. No increase in value per structure is projected during the study period, either for existing or new or replacement units or for the content value of commercial, industrial, public, and semipublic units. Residential content values, however, are expected to increase over time with increases

in affluence (increases in per capita income in real terms). Residential content values for the flood plain areas are currently estimated at 40 percent of structural values. Increases in content values during the study period are projected on the basis of anticipated growth in resident per capita income for the three-county area as previously described. Such increases are projected to continue until residential content values reach a maximum of 75 percent of structural values. Additional increases in content value are not projected beyond the 75 percent limit. The effect of the affluence factor on future residential content values is shown by data in the next tabulation.

RESIDENTIAL STRUCTURE AND CONTENT VALUES - 1976 PRICES

	Existing Conditions	1990	2000	2010	2020	2030	2040-2090
YUBA RIVER: Reaches 1-4							
Residential:							
Number of Units	6,052	7,032	8,096	9,146	10,087	11,080	11,763
Average Value of Structures ($1,000)	15.0	17.3	18.8	20.1	20.6	20.8	20.8
Without affluence							
Average Value of Contents ($1,000)	6.0	6.9	7.5	8.0	8.2	8.3	8.3
Percent of Structural Value	40	40	40	40	40	40	40
With affluence							
Average Value of Contents ($1,000)	6.0	10.9	14.1	15.1	15.4	15.6	15.6
Percent of Structural Value	40	63	75	75	75	75	75
Mobile Homes:							
Number of Units	632	735	839	941	1,046	1,157	1,240
Average Value of Structures ($1,000)	7.7	9.3	10.3	11.1	11.4	11.4	11.4
Without affluence							
Average Value of Contents ($1,000)	3.1	3.7	4.1	4.4	4.6	4.6	4.6
Percent of Structural Value	40	40	40	40	40	40	40
With affluence							
Average Value of Contents ($1,000)	3.1	5.9	7.7	8.3	8.5	8.5	8.5
Percent of Structural Value	40	63	75	75	75	75	75
FEATHER RIVER below YUBA RIVER: Reaches 5-8							
Residential:							
Number of Units	13,618	17,413	21,611	25,452	27,142	28,565	29,343
Average Value of Structures ($1,000)	19.2	21.6	23.2	24.3	24.8	24.9	24.9
Without affluence							
Average Value of Contents ($1,000)	7.7	8.6	9.3	9.7	9.9	10.0	10.0
Percent of Structural Value	40	40	40	40	40	40	40
With affluence							
Average Value of Contents ($1,000)	7.7	13.6	17.4	18.2	18.6	18.7	18.7
Percent of Structural Value	40	63	75	75	75	75	75

RESIDENTIAL STRUCTURE AND CONTENT VALUES - 1976 PRICES (CONTINUED)

	Existing Conditions	1990	2000	2010	2020	2030	2040-2090
FEATHER RIVER below YUBA RIVER: Reaches 5-8 (Cont'd)							
Mobile Homes:							
Number of Units	772	995	1,228	1,443	1,570	1,687	1,761
Average Value of Structures ($1,000)	8.5	10.8	12.1	13.1	13.4	13.4	13.4
Without affluence							
Average Value of Contents ($1,000)	3.4	4.3	4.8	5.2	5.4	5.4	5.4
Percent of Structural Value	40	40	40	40	40	40	40
With affluence							
Average Value of Contents ($1,000)	3.4	6.8	9.1	9.8	10.0	10.0	10.0
Percent of Structural Value	40	63	75	75	75	75	75
FEATHER RIVER, OROVILLE to YUBA RIVER: Reaches 9-13							
Residential:							
Number of Units	11,366	14,888	17,415	20,518	24,654	29,124	32,393
Average Value of Structures ($1,000)	16.9	20.2	21.5	22.5	23.2	23.5	23.5
Without affluence							
Average Value of Contents ($1,000)	6.8	8.1	8.6	9.0	9.3	9.4	9.4
Percent of Structural Value	40	40	40	40	40	40	40
With affluence							
Average Value of Contents ($1,000)	6.8	12.7	16.1	16.9	17.4	17.6	17.6
Percent of Structural Value	40	63	75	75	75	75	75

SECTION IV - FLOOD DAMAGES UNDER EXISTING (PREPROJECT) CONDITIONS

33. General

This section describes flood characteristics and methodology used in developing average annual damages under existing (preproject) conditions, on the Yuba and Feather Rivers with existing flood control measures. Existing flood control measures include the Sacramento River Flood Control Project, Oroville and New Bullards Bar Reservoirs, nonstructural measures between the levees of Reach 1 on the Yuba River, and the designated floodway on the Feather River from the city of Oroville to Honcut Creek.

In 1963, at the time the Corps of Engineers reported on the Yuba River basin, the State and Federal governments concluded that three interrelated dams would be required to protect the lower Yuba and Feather River basins from the standard project flood -- Oroville Dam on the Feather River and New Bullards Bar and Marysville Dams on the Yuba River. Oroville Dam was completed in 1967, and New Bullards Bar Dam was completed in 1970. New Bullards Bar Dam controls only 487 square miles of the Yuba basin, leaving 809 square miles above the Marysville damsite uncontrolled. Thus, the Marysville Lake project is needed to provide the degree of protection envisioned when plans for the three-dam system were evolved.

Tangible direct flood damages have been evaluated on a monetary basis; secondary benefits have not. Intangible damages, such as loss of

life, impairment of health and living conditions, and other items not subject to monetary evaluation are excluded from the damage analysis.

34. <u>Flood characteristics</u>. -

Floods in the Yuba and Feather River basins are generally caused by winter rain-type storms which may occur at any time from November through April. Occasionally the runoff from direct precipitation is augmented by melting snow. A typical flood-producing storm may last for several days and is generally composed of a rapid succession of several individual storms which combine to produce high intensity peak flows on all streams in the basins. In the upstream tributary areas, runoff accumulates rapidly, and the floods produced are of high intensity but relatively short duration. Floodwater velocities are high, and damages to roads, bridges and improvements along the river are severe. In the lower reaches of the rivers, velocities decrease with the decrease in the stream gradient. The most destructive flood of record on the Yuba River occurred during the 20-day period between 21 November and 10 December 1950. A break occurred in the south bank Yuba River levee near Hammonton with widespread flooding covering about 43,200 acres. The total loss due to this flood was over $4 million, of which $3,620,000 was below Harry L. Englebright Dam. The most destructive flood on the Feather River occurred in December 1955. Breaks occurred in the Feather River levees near Yuba City and Nicolaus, and 100,200 acres were flooded. Total loss from this flood was in excess of $50 million. Historical floods are described in more detail in Appendix F, Hydrology, Hydraulics, and Reservoir Regulation.

35. Recent flood damages. -

The most recent significant floods on Yuba and Feather Rivers for which damage information is available occurred in November 1950, December 1955, December 1964, and January 1970. Primary damage from these floods for the area downstream from New Bullards Bar on the North Yuba River and on the Feather River, below Oroville Dam, based on prices and conditions at the time of the flood, are as follows:

Flood	Yuba River Damage	Feather River Damage
November 1950	$3,620,000	$ 222,000
December 1955 - January 1956	2,501,000	50,484,000
December 1964 - January 1965	1,675,000	4,270,000
January 1970	347,000	2,634,000

A breakdown of the December 1955 flood damage into major damage categories is given in the following tabulation:

Damage Category	Yuba River Damage	Feather River Damage
Agricultural	$ 386,000	$20,946,000
Residential	Negligible	10,764,000
Commercial	96,000	2,962,000
Industrial	242,000	3,101,000
Public facilities	1,777,000	12,711,000
Total	$2,501,000	$50,484,000
Total in 1976 Prices	$5,578,000	$112,341,000

The 1955 flood inundated 100,200 acres in the Feather River basin in the following reaches:

Oroville to Yuba City	16,600
Yuba City	2,000
Below Yuba City	57,000
Nicolaus area	24,600

With the exception of the 2,000-acre Yuba City area, flooding was on developed agricultural land, including suburban, commercial and industrial developments. The flood caused the evacuation of about 30,000 people, flooded 3,300 homes, disrupted normal community activities for several months, and drowned 6,000 head of livestock. However, the most tragic result was the loss of 38 human lives. If the 1955 flood were to occur today, under current prices and conditions, over 50,000 people would have to be evacuated and damages would be almost three times greater than those that occurred in the 1955 event. The peak flow at Oroville Dam site in 1964 exceeded the 1955 peak flow; however, the partially completed Oroville Dam reduced the peak to less than the 1955 peak, thus preventing an estimated $30,000,000 in damages if the levee would have breached, or $1,800,000 without levees being breached. Other large floods occurred in 1907, 1909, 1928, 1937, 1940, and 1942.

36. Types of flood damages. -

Flood damages in the flood plain were designated by classes and types of damages and were developed in accordance with the terminology contained

in paragraph 1-72, EM 1120-2-101, Survey Investigations and Reports, General Procedure. Under these guidelines, the tangible primary damages considered were physical damages caused by inundation and flood emergency losses or costs incurred in fighting or preparing for flooding.

- Residential damages include inundation losses to all residences and appurtenant residential structures and damages to grounds.

- Personal property and contents of residences were separated from damages to residential structures.

- Commercial damages include loss to all properties used in commerce, business, trade, servicing, or entertainment as distinguished from other properties used in industry, public administration, utility production and services, and transportation. Physical flood damages to commercial property and facilities include damages to land, buildings, equipment, supplies, merchandise, and other items used in the conduct of businesses.

- Industrial-utilities damages include inundation losses and destruction to industrial and public utilities properties. Facilities used in extracting, producing, manufacturing, and processing of commodities and heavy warehousing, and those involved in distribution are generally classified as industrial.

- Public utilities damages include losses to all utilities, such as railroads, electric, water, telephone plants, transmission lines and other similar facilities.

- Public and semipublic facilities damages include inundation losses to public and semipublic buildings, roads and bridges, streets, pavement, sidewalks, highway structures, parks, and other facilities including equipment and furnishings owned or operated by Federal, State, county or local government units.

- Agricultural damages including reestablishment costs of orchards, costs of debris cleanup and leveling, loss of crop returns when the duration and timing of flooding would prevent planting, and damages to equipment which would not be removed prior to flooding.

- Other losses to the public include the additional costs incurred during flood emergencies such as evacuation and reoccupation, flood fighting, disaster relief, levee repair, and extra duty for police, fire and military units.

37. Depth-damage relationships. -

Depth-damage relationships describe probable damages that will occur under different depth of flooding conditions, either as a percentage of the total value of damageable property or in the probable loss expected. The depth-damage relationships for structural and content damage categories used in this analysis were derived from historical flood survey data from the project and comparable flood hazard areas. These relationships are summarized in the next tabulation.

Depth-Damage Relationships in Percent

Flood Depth Over Ground In Feet

	0	1	2	3	4	5	6	7	8	26
Residential Structures	0	4.7	10.7	17.2	25.2	30.4	33.9	37.0	37.2	100.0
Residential Contents	0	4.7	34.8	56.6	69.4	76.9	81.7	83.7	85.9	100.0
Mobile Structures	0	6	11.9	13.5	20.6	37.1	43.2	54.1	63.2	100.0
Mobile Contents	0	0	3.1	36.1	61.4	71.1	80.1	83.4	86.2	100.0
Commercial Structures	0	3	10	13	25	29	32	33	34	100.0
Commercial Contents	0	5	21	35	52	59	65	70	75	100.0
Industrial Structures	0	10	15	20	21	22	22.5	23	24	100.0
Industrial Contents	0	7	16	26	32	38	41	42	43	100.0
Public & Semipublic Facility Structures	0	2	9	18	23	26	28	29	30	100.0
Public & Semipublic Facility Contents	0	4	10	32	50	58	64	67	70	100.0

Depth-damage relationships for public facilities, such as roads and bridges, and for emergency costs are derived from historical survey data and interviews of local officials. Total damage relationships associated with a given hypothetical level of flooding (see paragraph 39 for discussion on flow-damage relationships) are developed for these damage categories rather than specific depth-damage relationships.

Agricultural damage relationships are also developed for given hypothetical flood events on the basis of historical flood data from the study area and similar areas. Both crop and noncrop damages are estimated. Noncrop damages include debris cleanup, leveling, and damages to improvements such as roads, fences, irrigation systems, and other equipment that could not be removed prior to flooding. Crop damages include the loss of net returns plus cultural costs incurred prior to the probable percent of flooding, less any net returns which could be derived from planting alternative crops following the flood event. If a levee failure occurred in the study area, it is assumed that the duration of flooding and the subsequent debris cleanup and leveling efforts would prohibit the planting of substitute crops. Crop damages are, therefore, estimated as the loss of net returns plus cultural costs incurred prior to the flooding event. In addition to the above, such perennial crops as developed pastures or orchards may incur losses. For this analysis, it is assumed that an average of one-half of the useful life of pastures or orchards would be remaining at the time of flooding and the maximum loss of the stand is estimated as one-half of the establishment cost.

Maximum agricultural damages used in this analysis, including crop and noncrop damages and loss of stands where applicable, are summarized in the following tabulation. Damages associated with particular hypothetical flood events for individual reaches were derived from these maximum damages on the basis of the estimated depth and duration of flooding and historical survey data.

Maximum Agricultural Damages

Crop	Damages (per acre)
Orchards	$2,535
Field crops	335
Rice	165
Truck crops	745
Alfalfa and mixed pastures	365
Grains and hay	270
Native pasture	45

38. Flow-frequency relationships. -

Flow-frequency curves were prepared for several index stations to correlate flood damage and floodflow. The curves indicate the probable frequency of occurrence of damaging flows at selected index stations. Flood damages reaches and index stations are discussed in Section II. The flow-frequency curves used in this analysis for the Feather River below mouth of Yuba River and the Feather River at mouth index stations include the probable impact of upstream levee failures. Levee failures were assumed to occur when streamflow exceeded levee design capacity.

39. <u>Flow-damage relationships</u>. -

Flow-damage relationships describe the probable flood damages expected with various streamflows. They are derived by estimating the probable flood damages for several hypothetical floods of given streamflows. Intermediate damage points are interpolated from these estimates on the basis of proportionate changes in the magnitude of streamflows. The probable damages for hypothetical floods are estimated by identifying the associated flood plain area, inventorying this area by damage category and depth of flooding, and applying the appropriate depth-damage relationship. Probable damages from these flows expected for the 25-year, 50-year, 100-year and SPF flood events under existing conditions are summarized in the following tabulations.

Damages Under Existing Conditions
25-Year Event - 1976 Prices
(in thousands)

Reach	Agriculture	Residential Structures	Residential Contents	Mobile Home Structures	Mobile Home Contents	Commercial	Industrial	Public & Semipublic	Emergency Costs	Total
1	$ 754	$32	$38	$21	$17	$94	$22	$1,316	$ 0	$2,294
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	138	0	138
6	132	0	0	0	0	0	0	0	708	840
7	0	0	0	0	0	0	0	0	0	0
8	326	0	0	0	0	0	0	0	666	992
9	0	25	10	0	0	76	7	28	0	146
10	1,671	0	0	0	0	0	181	66	323	2,241
11	0	0	0	0	0	0	0	0	0	0
12	129	0	0	0	0	0	41	2	67	239
13	662	0	0	0	0	0	20	92	0	774
Total	$3,674	$57	$48	$21	$17	$170	$271	$1,642	$1,764	$7,664

Damages Under Existing Conditions
50-Year Event - 1976 Prices
(in thousands)

Reach	Agriculture	Residential Structures	Residential Contents	Mobile Home Structures	Mobile Home Contents	Commercial	Industrial	Public & Semipublic	Emergency Costs	Total
1	$ 859	$43	$53	$25	$24	$129	$ 30	$1,665	$ 0	$2,828
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	167	0	167
6	158	0	0	0	0	0	0	0	846	1,004
7	0	0	0	0	0	0	0	0	0	0
8	393	0	0	0	0	0	0	0	803	1,196
9	0	27	11	0	0	82	7	30	0	157
10	1,689	0	0	0	0	0	200	66	356	2,311
11	0	0	0	0	0	0	0	0	0	0
12	134	0	0	0	0	0	45	3	74	256
13	705	0	0	0	0	0	21	101	0	827
Total	$3,938	$70	$64	$25	$24	$211	$303	$2,032	$2,079	$8,746

Damages Under Existing Conditions
100-Year Event - 1976 Prices
(in thousands)

Reach	Agriculture	Residential Structures	Residential Contents	Mobile Home Structures	Mobile Home Contents	Commercial	Industrial	Public & Semipublic	Emergency Costs	Total
1	$1,095	$ 69	$ 87	$ 34	$ 40	$ 208	$ 50	$2,451	$ 0	$ 4,034
2	122	99	128	0	0	36	0	31	32	448
3	0	21,314	10,211	2,435	905	4,151	188	4,541	2,379	46,124
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	187	0	187
6	176	0	0	0	0	0	0	0	944	1,120
7	0	0	0	0	0	0	0	0	0	0
8	441	0	0	0	0	0	0	0	901	1,342
9	0	27	11	0	0	82	7	30	0	157
10	1,689	0	0	0	0	0	200	66	356	2,311
11	0	0	0	0	0	0	0	0	0	0
12	134	0	0	0	0	0	45	3	74	256
13	705	0	0	0	0	0	21	101	0	827
Total	$4,362	$21,509	$10,437	$2,469	$945	$4,477	$511	$7,410	$4,686	$56,806

Damages Under Existing Conditions
Standard Project Flood Event - 1976 Prices
(in thousands)

Reach	Agriculture	Residential Structures	Residential Contents	Mobile Home Structures	Mobile Home Contents	Commercial	Industrial	Public & Semipublic	Emergency Costs	Total
1	$ 3,933	$ 415	$ 521	$ 56	$ 48	$ 415	$ 180	$ 4,132	$ 0	$ 9,700
2	983	852	922	0	0	227	0	148	134	3,266
3	0	25,050	10,541	2,701	948	4,622	205	7,539	2,379	53,985
4	0	0	0	0	0	0	0	0	0	0
5	11,991	4,699	5,897	102	97	1,303	3,020	1,823	837	29,769
6	2,554	202	195	0	0	87	108	85	3,167	6,398
7	0	93,040	58,199	3,357	1,334	29,722	18,419	13,856	3,662	221,589
8	7,189	472	436	107	58	260	713	400	3,330	12,965
9	0	100	67	0	0	241	20	112	0	540
10	2,163	219	288	0	0	4	290	77	406	3,447
11	0	0	0	0	0	0	0	0	16	16
12	203	0	0	0	0	0	67	4	100	374
13	1,306	671	883	0	0	35	49	157	36	3,137
Total	$30,322	$125,720	$77,949	$6,323	$2,485	$36,916	$23,071	$28,333	$14,067	$345,186

40. <u>Damage-frequency relationships</u>. -

Damage-frequency relationships describe the probable frequency of occurrence of flood damages of varying magnitudes. They are usually derived by combining the damage-flow and flow-frequency relationships. As discussed in paragraph 20, theoretically, levees surrounding Marysville are high enough to prevent flooding from Yuba River waters; however, the city actually does not have complete flood protection because of factors, other than overtopping, that may result in levee failure. Levee failure could result from excessive levee erosion during a major flood, excessive seepage, lack of maintenance, or a combination of these factors. Marysville Lake, in conjunction with the already completed New Bullards Bar Reservoir will be of material assistance in protecting Marysville. In the computation of preventable damages it has been assumed that one levee failure would be prevented by storage at Marysville Lake every 500 years. Total damage-frequency relationships for selected points for each reach are summarized in the next tabulation.

Damage-Frequency Relationships
Existing Conditions - 1976 Prices
(in thousands)

	Frequency as percent chance damages are equalled or exceeded								
Reach	0.1	0.3	0.5	0.8	1.0	2.0	4.0	5.0	10.0
1	$ 16,791	$ 10,766	$ 8,464	$ 5,133	$ 4,034	$2,828	$2,294	$2,160	$1,156
2	7,496	3,900	2,069	784	448	0	0	0	0
3	86,710	59,760	62,345	58,632	46,124	0	0	0	0
4	133,224	0	0	0	0	0	0	0	0
5	88,318	47,290	33,055	191	187	167	138	125	90
6	24,566	19,733	5,498	1,162	1,120	1,004	840	770	560
7	436,120	313,901	246,210	0	0	0	0	0	0
8	114,408	86,284	14,252	1,371	1,342	1,196	992	898	642
9	36,342	12,027	1,307	306	157	157	146	121	56
10	42,018	20,654	5,722	2,754	2,311	2,311	2,241	2,078	1,659
11	21,398	3,707	47	8	0	0	0	0	0
12	37,937	7,295	608	302	256	256	240	203	108
13	113,255	57,335	7,757	1,728	827	827	774	652	338

41. Average annual damages. -

Average annual flood damages are the expected value of damages for a given economic condition and point in time. They are determined by weighting the estimated damages from varying degrees of flooding by their probability of occurrence and may be approximated by measuring the area under the appropriate damage-frequency curves using standard computerized integral procedures. Average annual flood damages computed for the 13 damage reaches under existing conditions and 1976 prices are as follows:

Reach	Average Annual Damages
1	$ 374,300
2	29,200
3	631,400
4	266,500
5	380,600
6	363,400
7	1,994,100
8	745,100
9	97,200
10	404,200
11	53,700
12	105,900
13	419,200
TOTAL	$5,864,800

SECTION V - WATER RESOURCES PROBLEMS

42. General. -

Water resources studies for the Marysville Lake project identified need for the following:

- Increased supplies of electric power
- Increased supplies of water for irrigation
- Higher degree of flood protection in Yuba and Feather River basins
- Opportunities for lake-oriented recreation
- Opportunities for recreation associated with free-flowing streams
- Enhancement of fish and wildlife resources

These problems and needs are summarized in the following paragraphs.

43. Power. -

The most recent available estimate of future need for electric peaking power in California is the October 1976 projection by the staff of the California Energy Resources Conservation and Development Commission, as discussed in Appendix I, Power. That projection indicates needs will increase as follows:

Year	(MW)	(mil kWh)
1975	28,800	137,100
1990	46,500	228,200
1993	49,800	251,000
1995	53,300	267,200

The FPC conducted studies in 1976 and January 1977 of the need for additional system peaking capability in the 1990's in the FPC Power Supply Area 46 (northern California and western Nevada). Results of the studies are summarized in letters from the FPC to Sacramento District, dated 26 July 1976, 24 August 1976, and 1 February 1977 included in Appendix B. Estimated loads used in the study were from those developed for the Western Systems Coordinating Council (WSCC) and shown in its "Reply to Federal Power Commission Docket R-362, Order 383-3," dated 1 April 1976. The study area is the "Pacific Southwest Power Area, Sub-Area D," which approximates Power Supply Area 46. The following tabulation shows the FPC's estimated loads in the early 1990's.

Estimated Annual Load Requirements

Year	Peak Demand MW	Energy GWh
1990 1/	31,000	161,800
1991	32,500	169,700
1992	34,200	177,900
1993	35,900	186,600
1994	37,600	195,700
1995 1/	39,500	205,200

1/ Obtained from WSCC-intervening years by interpolation.

Resources used in the FPC study of a 2,250 MW powerplant are from the WSCC report, "Summary of Estimated Loads and Resources," dated April 1976, updated to include all generating plants placed in service in 1976, under construction and planned. Additional information was obtained from individual utilities, as needed.

The need for peaking power is discussed in more detail in Appendix I, Power.

44. Water supply. -

Data from the California Department of Water Resources, in October 1976, indicate the potential shortage of water supply for the combined Central Valley Project - State Water Project system would be about as follows, with and without water conservation measures.

	Potential Shortage (million ac-ft)	
Year	Without conservation	With conservation
1990	1.7	1.4
1995	2.6	2.2
2000	3.0	2.6

The USBR has indicated by letter dated 2 April 1976, included in Appendix B, that yield from the Marysville Lake project could be used for meeting CVP water service demands as soon as the project can be constructed.

The need for irrigation water supply is discussed in more detail in Appendix J, Water Resources and Irrigation Supply.

45. <u>Flood damage reduction</u>. -

As discussed earlier in this appendix, the plan for provision of flood protection for the Feather-Yuba River basins was based on a three-dam system consisting of the completed Oroville and New Bullards Bar projects and Marysville Lake. Under existing conditions, with only the Oroville and New Bullards Bar projects completed, the basins are still subject to flood damage, with average annual damages estimated to total $5,865,000.

46. <u>General recreation</u>. -

Studies indicate that 80 percent of the day use and 50 percent of the overnight use of lake-oriented recreation facilities are derived from a market area within a 50-road mile radius and the remainder of the use comes from as far away as 150-road miles. Population within a 150-mile radius of the Marysville Lake project is expected to increase from 5.1 million in 1975 to 6.0 million in 1990 and 8.7 million by the year 2020. It is projected that there will be need for a significant number of additional outdoor recreation opportunities associated with the growing population.

Recreation use of streams, particularly the lower Yuba River, is severely limited by the lack of public lands and access to the streams. There presently exists a significant need for recreation opportunities of

this type. The river portion of the project is considered to have a market area of 50 miles, with over 80 percent of the users originating from this area, although there would be some use from more distant origins. Population within the market area is expected to increase from 345,000 in 1975 to 365,000 in 1990 and 535,000 in 2020.

Recreation needs are discussed in more detail in Appendix D, Recreation Resources.

47. Fish and wildlife resources. -

Studies indicate that there are important fishery resources associated with the Yuba River and that with implementation of enhancement measures these resources could be increased to the benefit of the commercial fishery as well as sport fishery.

Development of the California Central Valley for intensive agricultural and urban use has resulted in loss of wetlands for waterfowl. There is a need to develop marsh habitat to support waterfowl populations.

The need for fish and wildlife enhancement is discussed further in Appendix D, Recreation Resources.

SECTION VI - POSSIBLE SOLUTIONS

48. General. -

As discussed in Section VI of the Phase I General Design Memorandum, a number of alternative solutions were considered for meeting identified water resources problems and needs, including multiple-purpose projects at various sites; single-purpose projects; local protection projects; combination plans (storage and bypasses, etc.); nonstructural measures; and no action. On the basis of preliminary studies of accomplishments and significant impacts, three alternatives were selected for detailed study as follows:

- Combination bypass and raising Englebright Dam, Plan A.

- Dam at Parks Bar site (Yuba River only), Plan B.

- Dams at Parks Bar and Dry Creek, Plan C.

These alternatives are described briefly in the following paragraphs and are described in more detail in the Phase I General Design Memorandum.

49. Combination bypass and raising Englebright Dam, Plan A. -

Englebright Lake would be raised about 33 feet, to elevation 560 feet msl, providing 31,200 acre-feet of additional storage space and increasing

storage to about 100,000 acre-feet. A leveed bypass would be constructed to divert floodflows from the Yuba River, just upstream of Daguerre Point Dam, to the Bear River. This plan would provide standard project flood protection to the Marysville-Yuba City urban area and a water supply yield of about 10,000 acre-feet per year. The existing Narrows powerplants would be remodeled and would produce an estimated 50 million kWh annually, on the average, more than under existing conditions. The plan would include a hatchery for enhancement of salmon and steelhead resources; however, storage is insufficient to increase streamflow for fish over presently stipulated flows (70/250/400 cfs).

50. Dam at Parks Bar site (Yuba River only), Plan B. -

The lake would have a gross pool elevation of 560 feet, and a gross pool storage capacity of 514,000 acre-feet. The lake would be created by construction of a concrete dam with earth abutments on the Yuba River and would inundate Englebright Dam, Old Narrows Powerplant, and New Narrows Powerplant. A saddle dike would prevent impounded water from spilling over into Dry Creek. The plan would include a fish hatchery to mitigate for loss of spawning gravels and a multiple-level intake tower at the dam to provide temperature-regulated water (at temperatures optimum for fish) to the powerplant and outlet works for discharge to the lower river. The main powerplant would have conventional turbines with a capacity of 100 MW and would be operated to produce peaking power. A reregulating dam would be located 3 miles downstream, and a baseload powerplant with an installed capacity of 15 MW would be located at the afterbay dam.

This alternative would provide power, irrigation, flood control, recreation, and fish and wildlife benefits. It would provide SPF flood protection with a flood control reservation of 240,000 acre-feet. The average annual irrigation yield would be 115,000 acre-feet. The main powerplant would have a dependable capacity of 60 MW and would generate 380 million kWh per year of onpeak power. The plan would provide minimum flows for fish of 600/800/1,000 cfs, except in dry years when only 70/250/400 cfs could be guaranteed.

51. Dams at Parks Bar and Dry Creek, Plan C. -

The lake would have a gross pool elevation of 560 feet, and a gross pool storage capacity of 916,000 acre-feet. The lake would be created by construction of a concrete dam with earth abutments on the Yuba River and an earthfill dam on Dry Creek and would inundate Englebright Dam, Old Narrows Powerplant, and New Narrows Powerplant. The plan would be self-mitigating with respect to impacts on the anadromous fishery, and mitigation measures would be included for impacts on wildlife and cultural resources. The plan would include a fish hatchery, spawning channel, and management of spawning gravels for enhancement of salmon and steelhead. The reregulating dam would be located 3 miles downstream of the main dam on the Yuba River, and a baseload powerplant would be located at the afterbay. Both conventional and pumped storage powerplants at the Yuba River dam were studied with this alternative.

This alternative would provide the SPF flood protection. The average annual irrigation yield would be 150,000 acre-feet.

SECTION VII - IDENTIFICATION OF THE NED PLAN

52. Criteria. -

ER 1105-2-230 defines the National Economic Development (NED) plan as the plan "which addresses the planning objectives in the way which maximizes net economic benefits." The ER further states that "mitigation, preservation or enhancement measures shall be included when they are economically justified."

Of all the alternatives considered, a plan with dams on the Yuba River at Parks Bar and on Dry Creek would provide by far the highest net economic benefits. Therefore, that plan provided the basis for formulating the NED plan described in the next paragraph.

53. Description of the NED plan. -

The NED plan would include a 2,250 MW pumped-storage powerplant installed initially at the Yuba River dam, and a 15 MW baseload powerplant at the afterbay. The NED plan would provide 240,000 acre-feet of storage for flood control, and would provide sufficient releases downstream to meet existing water rights and fish flows desired by fish and wildlife agencies (600,800,1,000 cfs). Operation would result in a minimum pool of 367,000 acre-feet during the critical dry cycle.

Planned operation of the project would result in a firm new yield of 150,000 acre-feet being available in the Delta for export by the CVP.

The NED plan would provide facilities to fully utilize the recreation potential associated with the lake and would accommodate 390,000 recreation-days of initial annual use and 1,000,000 ultimately. Public access and picnicking sites would be provided along lower Yuba River.

A fish hatchery to provide annual escapement of 50,000 salmon and 10,000 steelhead would be constructed below the afterbay dam. In addition, spawning channels and a stream gravel management program would provide 20,000 salmon enhancement. The project would be self-mitigating with respect to impacts on fishery resources, and measures would be included to mitigate impacts on wildlife and cultural resources.

Costs and benefits for the NED plan are as follows:

	3-1/4 Percent	6-3/8 Percent
First cost[1/]	$1,096,000,000	$1,096,000,000
Annual cost[2/]	53,500,000	95,300,000
Benefits		
Power	97,300,000	91,700,000
Water supply	10,100,000	10,800,000
Flood control	5,600,000	5,000,000
Recreation	1,400,000	1,100,000
Fish enhancement	3,700,000	3,700,000
Area redevelopment	5,900,000	12,600,000
Total	$ 124,000,000	$ 124,900,000
B-C ratio		
Without ARA	2.2	1.2
With ARA	2.3	1.3

1/ Excludes costs for road betterments, cultural resources preservation, relocations assistance, and Federal lands transferred to the project.

2/ Excludes costs for road betterments, cultural resources preservation and relocations assistance.

SECTION VIII - IDENTIFICATION OF THE EQ PLAN

54. Criteria. -

ER 1105-2-230 defines requirements for the Environmental Quality (EQ) plan as follows:

- Address as many water resource needs as possible

- Emphasize aesthetic, ecological, and cultural contributions while addressing water resource needs

- Be fully implementable

- Be acceptable to a significant segment of the public

The ER recognizes that environmental quality has both natural and human manifestations and that beneficial contributions to environmental quality are made by preserving, maintaining, restoring, or enhancing significant cultural and natural environmental attributes of the study area.

55. EQ alternatives. -

The three alternatives selected for detailed study are:

- Combination bypass and raising Englebright Dam, Plan A

- Dam at Parks Bar (Yuba River only), Plan B

- Dam at Parks Bar and Dry Creek (Marysville Lake project), Plan C

All satisfy the basic criteria for an EQ plan and were considered as EQ plan candidates.

56. Selection of EQ plan. -

The following step-by-step procedure was used in selecting the best EQ plan from these three alternatives.

a. The significant beneficial and adverse environmental impacts of the alternative plans were displayed and compared. The trade-offs involved between the plans were evaluated, and modifications were made to the plans to minimize adverse impacts and to maximize positive contributions. Specifically, a 300 MW conventional peaking plant was used for Plan C, rather than a pumped-storage facility, so that fossil fuels would be conserved.

b. The plans then were arrayed in order of increasing negative effects on the environment as follows:

(1) Plan A

(2) Plan B

(3) Plan C

c. A trade-off analysis was performed next to determine if the additional negative effects of implementing Plan B rather than Plan A would be outweighed by the additional positive contributions of Plan B. It was found that the incremental negative impacts of Plan B would be:

- Loss of baseload power by inundation of existing Narrows powerplants

- Inundation and disruption of 1,000 additional acres of mostly undeveloped land

- Inundation of 8 miles of spawning gravels and free-flowing stream

- Inundation of cultural resources

- Removal of land from University of California Field Station.

It was found that the incremental beneficial contributions of Plan B would be:

- Larger gain in peaking power

- Much higher guaranteed flows in the lower Yuba River for improvement of fish and wildlife resources

- Much greater water supply yield for production of food

- Improved regulation of water temperatures in lower Yuba River

- A more comprehensive cultural resources data recovery program to improve man's knowledge of his past

It was concluded that Plan B would made a far greater contribution to fulfilling the planning objectives than would Plan A; that the incremental positive contributions of Plan B outweighed the incremental negative impacts, and that the negative impacts would be largely mitigated, and that Plan B therefore would be a better EQ plan than Plan A.

d. A similar trade-off analysis then was conducted for Plans B and C. The incremental negative impacts of Plan C (with a conventional powerplant) over Plan B would be:

- Loss of Dry Creek riparian habitat

- Large increase in numbers of cultural resources sites inundated

- Increase in acreage of U.C. Sierra Foothill Range Field Station lands required

- Doubling of total acres inundated

- Loss of revenue to Browns Valley Irrigation District due to acquisition of land presently within the District's assessment area

The incremental beneficial contributions of Plan C would be:

- Increase in peaking power

- Small increase in water supply yield, but the water supply yield and guaranteed minimum flows would be assured through the critical dry cycle

- A more comprehensive cultural resources recovery program.

It was concluded that Plan C (with conventional powerplant) would make a significant additional contribution to fulfillment of the planning objectives; that the incremental negative environmental impacts of Plan C would, however, outweigh the incremental positive contributions; and that even though the impacts would be largely mitigated, the negative effect of inundating part of Dry Creek watershed resulted in Plan C having less net positive contributions to environmental quality than Plan B. Therefore, Plan B would be a better EQ plan than Plan C.

e. Based on the above analysis, Plan B has been designated as the EQ plan.

57. Description of the EQ plan. -

This plan, consists of a dam on the Yuba River at the Parks Bar site, with 514,000 acre-feet of storage at gross pool and an afterbay. The plan would provide enough reservoir storage to control the standard project flood on Yuba River to 120,000 cfs, the design capacity of the levee system. The plan would provide guaranteed Yuba River minimum flows of 600/800/1,000 cfs (600 cfs during June through September, 800 cfs in May and October through January, 1,000 cfs during February through April) except during dry years when only 70/250/400 could be guaranteed. Those augmented flows would be pumped out of the Delta to yield an average of 115,000 acre-feet of water supply annually. Selective releases through multiple-level outlets would allow regulation of downstream water temperatures seasonally to meet the needs of the anadromous fishery, recreationists, and irrigators. A 100 MW conventional hydroelectric plant at the main dam would have a dependable capacity of 60 MW and would generate approximately 380 million kWh of on peak power annually. A baseload powerplant at the afterbay dam would generate about 100 million kWh annually, but there would be a loss of 275 million kWh generated annually at the two existing Narrows powerplants to be inundated. Approximately 8 miles of fish spawning gravels on Yuba River and Deer Creek would be inundated by the reservoir, although their loss would be fully mitigated by the increased flows, regulated temperatures, and a fish hatchery which would add 70,000 salmon and 10,000 steelhead to the existing Yuba River runs.

About 21,500 acres of land would be acquired for this plan, including 2,500 acres for preservation of riparian vegetation along the lower Yuba River and Dry Creek to mitigate for losses of riparian habitat due to the project and 3,000 acres in the Hackett Creek area for wildlife mitigation. Water-oriented recreation opportunities would be enhanced by increased access to lower Yuba River and by increased lake recreation opportunities. Existing facilities inundated at Englebright Lake would be replaced at the new lake. Approximately 80 known prehistoric and historical sites would be inundated by the project, but mitigative and protective measures for the documentation, preservation, restoration, and salvage of cultural resources would be included in the plan. The ruins of Timbuctoo and the historic Bridgeport Bridge would both be in the pool area; the Timbuctoo Wells Fargo Building would be relocated and restored; the Bridgeport Bridge would be raised and preserved. Approximately 770 acres of the University of California Sierra Foothill Range Field Station would be acquired, resulting in a loss of the research base represented by those lands.

The EQ plan would have a benefit-to-cost ratio of 0.98 to 1 at 3-1/4 percent interest and 0.5 to 1 at 6-3/8 percent interest.

SECTION IX - THE SELECTED PLAN

58. <u>The selected plan</u>. -

The EQ Plan, in effect, would sacrifice economic efficiency (power revenues from pumped storage) to gain nonmonetary environmental benefits (conservation of fossil fuels, preservation of riparian habitat, and less adverse environmental impacts in general). On the other hand, the NED plan would maximize economic efficiency, but would sacrifice such environmentally-desirable measures as preservation of the Dry Creek watershed and would require use of baseload energy for pumpback. It is believed that the plan to be selected for implementation should strike a balance between the NED and EQ plans: it should provide both economic efficiency and environmental enhancement.

An alternative was sought which would combine environmentally desirable measures of the EQ plan with economically desirable elements of the NED plan, so that the greatest possible overall fulfillment of the planning objectives would result. A further consideration was that it be acceptable to the largest possible cross section of the public.

The Marysville Lake plan with pumped storage power was selected as the plan which meets the criteria best, as described in Section VIII of the Phase I General Design Memorandum. As in the NED plan, a 2,250 MW power-plant at the main dam and a 15 MW powerplant at the afterbay dam would be

included. However, only 1,350 MW would be installed initially at the main dam since a 1,350 MW pumped storage plant is the maximum size plant that is not a net energy user. All of the fish and wildlife mitigation and enhancement measures contained in the EQ plan would be incorporated in the selected plan. The selected plan would provide guaranteed Yuba River minimum flows of 600/800/1,000 cfs for the benefit of fish and wildlife and recreationists, with reductions of 15 to 30 percent during the critical dry cycle; this could not be accomplished with the EQ plan. The water supply yield would be 150,000 acre-feet as compared to 115,000 acre-feet with the EQ plan, and it would be firm through the dry cycle.

Therefore, Plan C has been chosen as the selected plan for Marysville Lake project. The selected plan is described in detail in Section X of the General Design Memorandum and in Appendix L, Basis of Design of Selected Plan.

59. Power benefits.-

a. Main powerplant (staged development). -

Power accomplishments. - The dependable capacity of the main powerplant (staged construction) would be 1,260 MW initially and 2,030 MW after installation of the two additional units in year 2000. The average annual energy production of the staged powerplant would be 1,660 million kWh, with the average annual energy production of the 2,250 MW installation being 1,720 million kWh. The facility would be operated

to provide peaking power. With an annual capacity factor of 10 percent, the most likely alternative to the pumped-storage power project would be a combustion turbine generating plant. Transmission and pumping costs are included in the following analyses. The latest power values available from the FPC are calculated at 6-1/8 percent and are based on January 1976 prices. Therefore, the separable costs for power have been computed on the same basis for this analysis.

Comparability test. - Corps of Engineers' criteria require that the separable costs for power be compared to the Federally-financed costs of the most likely thermal alternative. As discussed in Appendix I, Power, both the 2,250 MW and the 1,350 MW plants meet the comparability test at 3-1/4 and 6-1/8 percent interest rates.

Power benefits. - Power benefits were computed for the main powerplant with staged development, based on the power accomplishments and power values furnished by the FPC using composite non-Federal financing costs for the combustion turbine alternative. The annual capacity value would be $26.89/kW-year and the energy value would be 28.97 mills/kWh ($0.02897/kWh). Average annual equivalent power benefits for the staged 2,250 MW powerplant would be as listed in the next tabulation. The ratio of power benefits to separable power costs indicates that adding the power function is economically feasible.

	3-1/4%		6-1/8%	
	1,350 MW	2,250 MW	1,350 MW	2,250 MW
Capacity benefits, million dollars 1/	33.8	54.6	33.8	54.6
Energy benefits, million dollars	32.6	49.8	32.6	49.8
Total benefits 2/	$90,600,000		$82,100,000	
Separable power costs 3/	35,600,000		52,200,000	
Net benefits	55,000,000		29,900,000	
Power benefit-to-separable cost ratio	2.5		1.6	

1/ Annual benefits after initial filling of reservoir.
2/ Adjusted to account for initial filling of reservoir, and with 1,350 MW installed in 1990 and 900 MW additional installed in 2,000. Benefits are at load center.
3/ Includes transmission costs and offpeak pumping costs at 3.24 mills/kWh.

A sensitivity analysis was made to determine the impact of higher pumping costs. Average annual pumping costs in millions of dollars are as follows:

Pumping cost mills/kWh	3-1/4 Percent 1,350 MW plant	3-1/4 Percent 2,250 MW plant	6-1/8 Percent 1,350 MW plant	6-1/8 Percent 2,250 MW plant
3.24	3.1	6.1	2.9	5.9
10.0	9.5	18.9	9.1	18.2
17.18	16.3	32.5	15.6	31.2

The effect of using various pumping costs on the benefit-cost ratio for the staged project is shown in the following tabulation. (Total project benefits are summarized in paragraph 65.)

	Pumping costs (mills/kWh)		
	3.24	10.0	17.18
3-1/4 Percent Interest			
Annual costs, million dollars	51.0	62.2	74.1
Annual benefits, million dollars	113.4	113.4	113.4
Benefit-cost ratio	2.2	1.8	1.5
6-3/8 Percent Interest			
Annual costs, million dollars	87.3	97.2	107.6
Annual benefits, million dollars	108.4	108.4	108.4
Benefit-cost ratio	1.2	1.1	1.01

The foregoing data indicate that the project would be economically feasible at both 3-1/4 and 6-3/8 percent interest rates with pumping costs of up to 17.18 mills per kWh.

b. 1,350 MW installation. - For comparative purposes, benefits for a 1,350 MW power installation also were computed and are shown in the following tabulation.

Annual Benefits and Costs	1,350 MW Installation 3-1/4%	6-1/8%
	(Millions of dollars)	
Capacity benefits 1/	33.8	33.8
Energy benefits 1/	32.6	32.6
Total benefits 2/	63.4	61.2
Separable power costs 3/	25.2	42.6
Net benefits	38.2	18.6
Power benefit-to-separable cost ratio	2.5	1.4

1/ Annual benefits after initial filling of reservoir.
2/ Annual benefits adjusted to include initial filling of reservoir. Benefits are at load center.
3/ Includes transmission costs and offpeak pumping costs at 3.24 mills/kWh.

c. 2,250 MW initial installation. - For comparative purposes, benefits for a 2,250 MW initial power installation also were computed and are shown in the following tabulation.

Annual Benefits and Costs	2,250 MW Installation 3-1/4%	6-1/8%
	(Millions of dollars)	
Capacity benefits 1/	54.6	54.6
Energy benefits 1/	49.8	49.8
Total benefits 2/	99.7	96.2
Separable power costs 3/	35.9	58.8
Net benefits	63.8	37.4
Power benefit-to-separable cost ratio	2.8	1.6

1/ Annual benefits after initial filling of reservoir.
2/ Annual benefits adjusted to include filling of reservoir. Benefits are at load center.
3/ Includes transmission and offpeak pumping costs at 3.24 mills/kWh.

d. Afterbay powerplant. - The dependable capacity of the 15 MW afterbay powerplant would be 14 MW, and the average annual energy production would be 110 million kWh. The facility would be operated to supply baseload power with an average annual capacity factor ranging from 75 to 85 percent. Accordingly, the most likely thermal alternative would be a nuclear generating plant. Studies indicate the output of the afterbay powerplant is not affected significantly by staged construction of the main powerplant.

Comparability test. - As discussed in Appendix I, Power, a 15 MW afterbay powerplant meets the comparability test at 3-1/4 percent interest rate, but does not for 6-1/8 percent interest rate. However, in view of feasibility at lower interest rates, the need for energy, and the shortage of fuel resources, the afterbay powerplant is included in the total project.

Power benefits. - Power benefits were computed on the basis of composite non-Federal financing costs for the nuclear generation alternative. The annual capacity value would be $100.07/kW-year and the energy value would be 3.16 mills/kWh ($0.00316/kWh).

Annual Benefits and Costs	15 MW 3-1/4%	15 MW 6-1/8%
	(Millions of dollars)	
Total benefits	1.7	1.7
Separable power costs	0.7	1.3
Net benefits	1.0	0.4
Benefit-to-separable cost ratio	2.4	1.3

e. Summary of power benefits. - The benefits at load center for the main powerplant with staged development (2,250 MW plant with 1,350 MW initial installation) and the 15 MW afterbay powerplant are shown in the following tabulation to summarize the total power accomplishments of the Marysville Lake project. Values are shown in millions of dollars.

	3-1/4 Percent	6-1/8 Percent
Main powerplant	90.6	82.1
Afterbay powerplant	1.7	1.7
Total	92.3	83.8

60. Irrigation benefits. -

Irrigation benefits for the Marysville Lake project were computed by the U.S. Bureau of Reclamation (USBR). Farm budget analysis was the procedure used to derive direct irrigation benefits. The USBR formula, taking into account alternative costs, has been applied to the direct benefits to determine the irrigation benefits attributed to storage.

Since yield from the Marysville Lake project can be completely utilized in several areas of the San Joaquin Valley, no specific service area within the valley has been identified at this time. Ten farm budgets were derived to represent a cropping pattern based on the combined crop acreages of nine San Joaquin Valley counties. It was assumed that project water would be used on land that would not otherwise be productive, resulting in a negligible future benefit without project water. The project yield could be used to irrigate 50,000 acres of presently unirrigable lands.

The farm budgets shown and their resulting benefits were weighted in relation to the cropping pattern to derive a weighted net farm income of $234 per acre. Since farm income without project water is assumed to be $0, this translates into a total on farm direct irrigation benefit of $234 per acre. An average use of 3 acre-feet per acre (including conveyance and distribution losses) results in an on-farm direct benefit of $78 per acre of project water.

b. Indirect benefits. - Indirect benefits represent the income generative effects beyond those occurring to the direct water users. The farm output resulting from project water creates an increased dollar flow throughout a region's economy, and the regenerative effect of this dollar flow creates additional income for all sectors of the region's economy. An example of indirect benefits would be the increased incomes of persons involved in processing, transporting, and merchandising the farm products made possible by a project water supply.

An input/output model traces the regenerative effects of this dollar flow by measuring the interdependencies of a region's various economic sectors. The end result is the derivation of multipliers that estimate the additional income generated in all sectors of a region's economy because of increased output in one sector.

The next tabulation summarizes the indirect benefit determination for the Marysville Lake project.

DERIVATION OF INDIRECT IRRIGATION BENEFITS

Crop	Gross 1/ Income Per Acre ($)	Income 2/ Multiplier	Household Income Per Acre ($)	Weight 3/ (%)	Weighted Income ($)
Corn	344	.3336	115	4.27	4.91
Wheat	276	.3336	92	9.40	8.65
Alfalfa	394	.3921	154	12.13	18.68
Sugar Beets	1,011	.6916	699	2.27	15.87
Cotton	483	.3861	186	23.58	43.86
Cotton Seed	108	.4271	46	(23.58)	10.85
Barley	219	.3336	73	8.85	6.46
Grain Sorghum	259	.3336	86	2.50	2.15
Dairy	666	.2486	166	14.55	24.15
Cantaloupe	1,842	.6247	1,151	1.34	15.42
Tomatoes	1,157	.7739	895	2.51	22.46
Lettuce	1,862	.8322	1,550	1.27	19.69
Almonds	1,499	.6528	979	3.14	30.74
Walnuts	497	.5241	260	1.81	4.71
Apricots	1,328	.6247	830	1.88	15.60
Grapes	1,223	.7375	902	8.29	74.78
Lemons	3,402	.4145	1,410	2.21	31.16
		Total		100%	$350.14

Total Benefits Per Acre = $350.14

Less: Direct Benefits Per Acre = $234.00

Total Indirect Irrigation Benefits Per Acre = $116.14

Rounded = $116/Acre

1/ Gross income per acre is based on the yields and prices used in the farm budget analysis for Marysville Reservoir.

2/ The multipliers used are taken from an input/output model for Fresno County developed by the University of California Extension Service. Household sector multipliers from the model's inverse matrix were used.

3/ Weights are based on the cropping pattern used for farm budget analysis.

The income multipliers used were taken from an input/output model developed for Fresno County by the University of California Extension Service. The multipliers were applied to the gross crop incomes derived from increased crop production to estimate a total household income of $350 per acre. By subtracting the portion of that income already accounted for in the direct irrigation benefit, a total indirect irrigation benefit of $116 per acre remains.

c. Documentation. - The farm budgets used for the direct benefit determination were based on a general knowledge of the types of agriculture in the San Joaquin Valley. The specific data sources used are documented with each budget, the general data sources are briefly discussed below.

(1) Prices received. - The crop, milk, and livestock prices used in the budgets were derived using procedures outlined by the October 1974 Water Resources Council guidelines. The procedures were applied to 11 years (1964-74) of price data obtained from the California Crop and Livestock Reporting Service to arrive at the normalized prices used. The normalized prices used in the grape budgets applied the same procedures to 7 years (1968-74) of price data obtained from the Crop Reporting Service and the Tokay Marketing Agreement.

(2) Yields. - The yields for each of the crops represented were derived considering data from:

- Historical trends in yield from Agricultural Commissioner's Annual Crop Reports for San Joaquin Valley counties.

- Enterprise cost studies from the University of California Extension Service.

- Consultation with University of California Extension Service Farm Advisors familiar with the crops and general agriculture in the San Joaquin Valley.

(3) Cropping pattern. - The cropping pattern used was based on the County Agricultural Commissioner's Annual Crop Reports for Contra Costa, Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties. The acreages from these counties were combined to derive the percentages and weights shown in the tabulations showing derivation of direct and indirect irrigation benefits.

(4) Cultural practices and labor requirements. - General information such as cultural practices, equipment used, irrigation systems, machine time, and labor requirements were obtained from cost analysis worksheets published by the University of California Extension Service and from personal interviews with San Joaquin Valley Farm Advisors.

(5) Prices paid. - A 1974 price level is used for all prices in the budgets. All the costs associated with operating a farm were considered

in determining the net income for each budget. These costs include such items as depreciation, repairs, labor, taxes, insurance, interest on debt, and production expenses such as fertilizer and seed costs. Where actual 1974 costs were not readily available, appropriate price index factors were used to adjust costs to a 1974 level.

(6) Taxes and wages. - Taxes for land, improvements, and equipment were based on the average tax rates for San Joaquin Valley counties as reported by the California State Board of Equalization. Wages were based on an average wage paid to farm labor as reported by the California Crop and Livestock Reporting Service.

(7) Land value. - The land values used in the budgets are based on the agricultural use value of land as assessed under the guidelines of California's Williamson Act. The assessed values were taken from various San Joaquin Valley counties.

(8) Irrigation and drainage. - The irrigation system costs included in the budgets are based on the type of systems in general use for the crops represented in the various budgets. These costs range from $100 per acre for flood irrigation systems, to over $1,000 per acre for solid set frost protection sprinkler systems. The on-farm drainage costs are based on an estimate of $300 per acre for installed tile drains. It is estimated farm drainage may be required on about one-half of the valley's acreage; therefore, a representative cost of $150 per acre was used in each budget.

d. <u>Basis for costs used in USBR formula</u>. -

(1) <u>Conveyance cost</u>. - The Central Valley Project (CVP) water storage facility operations are integrated to provide a maximum water supply for the various authorized water users. This maximized supply is available only through coordinated operation of all CVP storage facilities. Separate operation of the same storage facilities would provide a smaller water supply. When Marysville Lake is integrated into the CVP, it will add more to CVP supply when operationally integrated than it could operating alone.

CVP conveyance facilities will be used to transport the Marysville Lake yield to the most likely area of use, the San Joaquin Valley. Therefore, use of a composite CVP irrigation conveyance cost is considered to be representative of the cost of conveying Marysville water to its place of use.

(2) <u>Distribution system costs</u>. - Since Marysville Lake yield can be completely utilized in several areas of the San Joaquin Valley, no specific service area within the valley is being identified at this time. Therefore, a composite representative distribution system cost has been compiled and used in lieu of an actual distribution system cost. This cost includes a mix of open, closed low pressure, and closed high pressure distribution systems.

a. Direct benefits. - Direct irrigation benefits are defined as the net income received by the farm operator resulting from a project water supply. Farm budget analysis measures this income by budgeting farm enterprises considered typical of a project service area. By formulating the budgets under future conditions, with and without a project water supply, the net farm income attributable to project water can be determined.

The derivation of direct irrigation benefits is shown in the following tabulation.

DERIVATION OF DIRECT IRRIGATION BENEFITS

COL. 1 Budget and Crops	COL. 2 Acres	COL. 3 1/ Cropping Patterns Crops	COL. 4 1/ Cropping Patterns Percentages	COL. 5 2/ Weight of Budget	COL. 6 3/ Benefits Per Acre	COL. 7 4/ Weighted Benefits
		Dry Beans	1.63			
#1 Field Crop	320	Corn, Grain	2.64			
Corn	45	Alfalfa Hay	11.44			
Wheat	75	Rice	1.22	28.07%	$181.83	$ 51.04
Alfalfa	150	Safflower	1.45			
Sugar Beets	40	Sugar Beets	2.27			
		Wheat	6.73			
		Alfalfa Seed	.69			
#2 Field Crop	320					
Cotton	230	Cotton	23.58			
Barley	80	Barley	8.85	34.93%	$189.63	$ 66.24
Grain Sorghum	(55)	Grain Sorghum	2.50			
#3 Dairy	240					
Cows	150 Cows					
Pasture	70	Corn Silage	4.14			
Alfalfa Hay	100	Other Hay	1.82	14.55%	$231.22	$ 33.64
Barley	63	Irr. Pasture	8.59			
Corn Silage	(63)					
		Lettuce	.30			
		Melons	.69			
#4 Truck Crop	120	Onions	.26			
Cantoloupe	21	Peppers	.03	5.12%	$305.51	$ 15.64
Tomatoes	96	Tomatoes	2.51			
Lettuce	(21)	Asparagus	.45			
		Carrots	.23			
		Potatoes	.65			
		Almonds	3.14			
#5 Fruit & Nut	120	Apricots	.30			
Almonds	68	Figs	.29	6.83%	$321.76	$ 21.98
Walnuts	40	Peaches	1.06			
Apricots	10	Plums	.23			
		Walnuts	1.81			
#6 Citrus	20	Citrus	2.21	2.21%	$532.95	$ 11.78
Lemons	19					
#7 Vineyard	80					
Wine Grape	77			2.07%	$528.67	$ 10.94
#8 Vineyard	80					
Zinfandel	78			2.07%	$489.43	$ 10.13
#9 Vineyard	80	Grapes	8.29			
Wine Tokay	66			2.08%	$292.52	$ 6.08
Fresh Tokay	12					
#10 Vineyard	80					
Wine Grapes	77			2.07%	$313.76	$ 6.49
TOTALS			100%	100%		$233.96/Acre

Total on Farm Direct Irrigation Benefit = $234.00 per Acre

1/ The crops and percentages shown are derived from the combined crop acreages from the Agricultural Commissioners' Annual Crop Reports for nine San Joaquin Valley counties.
2/ Weights shown are derived from totaling percentages in column 4.
3/ Represents net farm income per acre as derived from farm budget analysis.
4/ Derived by multiplying column 6 by column 5.

(3) Drainage costs. - The drainage needs of the valley are presently under study. Pending the results of this study, drainage facility needs and costs for San Joaquin Valley can best be approximated by using San Luis drainage facilities. Within the San Luis service area,drainage facilities have been planned for 300,000 acres of some 600,000 total acres. All project water users will be required to repay the cost of the main and collector drain facilities.

It is estimated that approximately one-half of the acreage in San Joaquin Valley will require similar facilities.

Based on the previous discussions, the conveyance, distribution and drainage costs for use in the USBR formula are summarized as follows:

CVP irrigation conveyance (Capital & OM&R)			$ 4.00/ac.-ft.
Distribution System	"	"	8.00/ac.-ft.
Drainage System	"	"	3.00/ac.-ft.
Total			$15.00/ac.-ft.

e. Irrigation benefits attributed to storage. - Employing the USBR formula and utilizing the single-purpose cost for storage together with the above costs, the direct irrigation benefits per acre-foot at the Marysville Reservoir have been computed at 3-1/4 and 6-3/8 percent as follows:

Formula

$$\text{Net direct irrigation benefits at the farm} \times \frac{\text{(single-purpose irrigation storage costs)}}{\text{(Total single-purpose irrigation facility costs for storage, main conveyance and distribution and drainage facilities)}} = \text{Direct irrigation benefits attributable to storage}$$

(1) Application of formula (per acre-foot values). -

At 3-1/4 percent:

Single-purpose storage cost (annual) $13,300,000 ÷ 150,000 ac.-ft. = $88.67/ac.-ft.

$$\$78 \times \frac{(\$88.67)}{(\$88.67 + 15.00)} = \$67.08/\text{ac.-ft. attributed to storage}$$

At 6-3/8 percent:

Single-purpose storage cost (annual) $25,590,000 ÷ 150,000 ac.-ft. = $170.60/ac.-ft.

$$\$78 \times \frac{(\$170.60)}{(\$170.60 + 15.00)} = \$71.76/\text{ac.-ft. attributed to storage}$$

(2) Total project irrigation benefits. - Applying the above per acre-foot values to the 150,000 acre-foot project yield gives the following values of irrigation benefits.

At 3-1/4 percent:

$$150{,}000 \text{ ac.-ft.} \times \frac{\$67.08}{\text{ac.-ft.}} = \$10{,}062{,}000$$

(rounded to $10,100,000)

At 6-3/8 percent:

$$150{,}000 \text{ ac.-ft.} \times \frac{\$71.76}{\text{ac.-ft.}} = \$10{,}764{,}000$$

(rounded to $10,800,000)

61. Flood Control benefits. -

a. Preproject conditions. -

(1) Nonstructural measures. - Initiation of land use criteria in flood prone areas is the responsibility of local communities or local governmental entities. Support for local action is available through the National Flood Insurance Act of 1968, as amended on 10 September 1971 and 22 January 1972, and the State of California Cobey-Alquist Flood Plain Management Act, Chapter 4, 1965.

The principal purpose of the National Flood Insurance Act is "to prescribe minimum requirements for adequate land use and control measures for flood prone areas that a community must adopt, based upon the amount of relevant technical data available to it, in order to obtain flood insurance. The overall purpose of these criteria is to encourage only that development of flood damage and the need to reduce flood losses, that represents an acceptable social and economic use of the land in relation to the hazards involved, and that does not increase the danger to human life; and to discourage all other development."1/

1/ Quote from Dept. of Housing and Urban Development, Federal Register, 36 F R Sept. 1971.

The Flood Disaster Protection Act of 1973 expanded the National Flood Insurance Program. Essentially, communities identified as having flood prone areas are required to participate in the flood insurance program or they become ineligible for Federally related financing for projects that would be located in such areas. The local government body must control development at approximately the 100-year flood unless it is determined for good cause that such a standard would not be economically and socially desirable and would unreasonably curtail future growth and vitality.

The Cobey-Alquist Flood Plain Management Act states that "The primary responsibility for planning, adoption, and enforcement of land use regulations to accomplish flood plain management rests with local levels of government." The principal function of the State under the act is to render technical assistance to, and review flood plain management plans of local levels of government. There are numerous nonstructural flood control methods, but basically the techniques are either regulatory or nonregulatory, as follows:

Nonregulatory

- Voluntary floodproofing.
- Fee purchase (public or private) of flood prone land to restrict development to open-space use.
- Public or private acquisition of flood control easements to prevent or control development.

- "Favored" tax treatment to encourage open-space use.

- "Flood conscious" governmental policies in public service and public land use in flood hazard areas.

- Urban renewal programs.

- Flood warning systems.

- Relocations.

Regulatory

- Prevent obstruction to floodflows in flood areas through zoning, subdivision, and encroachment regulations.

- Require minimum protection levels through elevation or other flood-proofing of damageable property such as zoning, housing codes, subdivision regulations and State level administrative regulations.

- Miscellaneous regulations, such as requiring flood hazard disclosure in real estate transactions, sanitary and health codes, and official mapping of flood prone areas.

Regulatory measures are most useful in avoiding flood losses to future development, not in controlling losses to existing development.

(2) Future nonstructural measures in flood plain. - It is assumed that all future development will at least be in compliance with the minimum

standards established by the National Disaster Protection Act of 1973. A discussion of the evaluation for specific areas within the flood plain is presented below.

Some portions of Reach 1 are subject to flooding from the 100-year and more frequent events. As a preproject condition, it is assumed that future development within reach 1 will be in conformance with the special encroachment provisions for the Yuba River previously described. Such provisions exceed the minimum standards required by the National Flood Disaster Protection Act of 1973.

Except for some agricultural areas and such public facility and utility developments as roads and transmission lines located between the levees, reaches 2 and 3 and reaches 4-8 and 11-13 are already afforded 80-year or greater protection by the Sacramento River Flood Control Project levees and Oroville and New Bullards Bar Reservoirs. Providing additional protection to the urban areas in these reaches through nonstructural measures is impractical considering the depth of flooding that would result in the event of a levee failure. Depths of flooding of 3-7 feet in the Yuba City and Linda and Olivehurst areas and 26 feet in the city of Marysville would make the cost of such nonstructural measures as elevation or relocation of structures prohibitive when considering the extent of current development.

Those portions of reaches 9 and 10 between Oroville and Honcut Creek that are subject to flooding at less than the 100-year event are

located within the Feather River Designated floodway zone. From Honcut Creek to Marysville all reach 10 land areas are located within the existing Sacramento River Flood Control Project levees. No significant development has yet occurred within this portion of reach 10, and none is expected in the future. The remainder of reach 10 is generally rural in composition. For the most part farmstead structures have been constructed on the highest ground available and are subject to flood damage on only rare occasions. Such voluntary floodproofing is expected to continue in the future. Some portions of the city of Oroville (reach 9) are also subject to floodwaters on rare occasions when the State highway below Oroville is overtopped, causing flood depths of about 8 to 12 feet within the city. Considering the depths, frequency of flooding and existing development, nonstructural measures are considered impractical in this area.

b. Preproject damages. - Estimates of potential flood damages under existing and probable future conditions were made for each category of damage for the 13 reaches. Estimated future damages were based on relations developed from data presented earlier in this appendix, from field survey of the property and improvements within the limits of various-sized flood plains, and from depths of flooding for the different flood plains. These data were modified to allow for conditions expected to prevail in the future. Average annual future losses were computed using standard damage-frequency methods for the 100-year period, 1990-2090, corresponding to the assumed amortization period of the project. Estimated preproject damages are shown in the next tabulation.

AVERAGE ANNUAL PREPROJECT DAMAGES - 1976 PRICES (1)
(In Thousands)

	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090	AVERAGE ANNUAL EQUIVALENT 1990-2090
REACHES 1-4								
Agriculture	$ 159.2	$ 201.1	$ 221.9	$ 245.0	$ 268.1	$ 293.2	$ 291.9	$ 250.6
Residential Structures	357.6	568.7	749.3	942.3	1,116.4	1,282.2	1,388.3	992.2
Residential Contents	171.0	256.3	336.1	421.4	498.9	573.3	621.3	444.2
(With Affluence)	(171.0)	(402.7)	(615.2)	(770.2)	(902.8)	(1,058.5)	(1,155.8)	(811.1)
Mobile Home Structures	38.0	54.1	68.7	84.2	99.0	113.5	123.3	89.1
Mobile Home Contents	14.4	19.9	25.0	30.5	35.7	40.8	44.3	32.3
(With Affluence)	(14.4)	(31.3)	(46.0)	(55.8)	(64.5)	(75.3)	(82.4)	(58.9)
Commercial	123.9	157.5	182.7	211.4	235.7	256.9	271.8	217.2
Industrial	84.0	97.4	107.4	116.1	121.3	125.0	128.1	115.4
Public & Semipublic Fac.	304.6	341.7	367.8	390.5	417.1	444.0	459.9	401.4
Emergency Costs	30.7	33.1	35.4	37.2	38.8	40.2	41.0	37.5
Sub-Total: Without Affluence	1,301.4	1,729.8	2,094.3	2,478.6	2,831.0	3,169.1	3,369.9	2,579.9
With Affluence	1,301.4	1,887.6	2,394.4	2,852.7	3,263.7	3,688.8	3,942.5	2,973.4
REACHES 5-8								
Agriculture	519.5	680.1	763.7	858.8	957.1	1,067.1	1,060.4	885.1
Residential Structures	1,052.4	1,536.9	2,041.0	2,516.9	2,713.0	2,855.7	2,909.4	2,405.8
Residential Contents	523.2	766.1	1,017.7	1,256.6	1,360.5	1,437.7	1,468.9	1,206.0
(With Affluence)	(523.2)	(1,203.7)	(1,861.0)	(2,307.3)	(2,473.9)	(2,671.7)	(2,748.4)	(2,207.5)
Mobile Home Structures	31.3	52.8	74.0	94.2	103.6	110.9	113.7	90.5
Mobile Home Contents	13.1	22.0	30.6	39.0	43.1	46.3	47.6	37.6
(With Affluence)	(13.1)	(34.5)	(55.8)	(71.4)	(78.5)	(85.9)	(89.0)	(68.9)
Commercial	280.9	373.1	444.7	523.5	598.3	675.1	729.3	550.8
Industrial	277.8	336.5	377.5	419.6	456.3	490.3	507.8	427.9
Public & Semipublic Fac.	216.6	291.7	349.0	400.6	454.4	505.4	532.0	417.5
Emergency Costs	568.4	576.9	584.1	589.4	591.1	592.4	593.2	587.7
Sub Total: Without Affluence	3,483.2	4,636.1	5,682.3	6,698.6	7,277.4	7,780.9	7,962.3	6,608.9
With Affluence	3,483.2	5,086.2	6,550.8	7,781.7	8,426.2	9,054.5	9,283.2	7,641.7
REACHES 9-13								
Agriculture	511.5	734.8	855.1	997.1	1,128.1	1,277.6	1,274.5	1,026.9
Residential Structures	190.9	302.8	375.0	459.2	568.7	681.2	760.1	515.6
Residential Contents	212.6	338.9	420.5	515.5	639.0	765.7	854.4	578.9
(With Affluence)	(212.6)	(532.5)	(773.1)	(948.4)	(1,148.1)	(1,409.7)	(1,587.0)	(1,056.6)
Commercial	44.8	65.7	79.1	93.7	107.5	124.3	134.1	99.3
Industrial	31.2	36.1	39.8	43.4	46.7	49.5	50.6	44.0
Public & Semipublic Fac.	45.4	60.3	73.6	85.5	96.6	106.2	113.0	88.3
Emergency Costs	43.8	47.0	48.5	50.1	52.0	53.7	54.8	50.9
Sub-Total: Without Affluence	1,080.2	1,585.6	1,891.6	2,244.5	2,638.6	3,058.2	3,241.5	2,403.9
With Affluence	1,080.2	1,779.2	2,244.2	2,677.4	3,147.7	3,702.2	3,974.1	2,881.6
Total: Without Affluence	5,864.8	7,951.5	9,668.2	11,421.7	12,747.0	14,008.2	14,573.7	11,592.7
Total: With Affluence	5,864.8	8,753.0	11,189.4	13,311.8	14,837.6	16,445.5	17,199.8	13,496.7

(1) 1976 prices at 3-½ percent interest rate.

c. Flood control accomplishments. - Objective flows with the Marysville Lake project are 120,000 cfs on the Yuba River at Marysville, 150,000 cfs on the Feather River at Oroville, 300,000 cfs in the Feather River below the Yuba River and 320,000 cfs at the mouth of the Feather River. (These flows approximate levee design capacities.) Marysville Lake will provide a high degree of protection to 25,000 acres protected by levees along the Yuba River and to 114,000 acres protected by levees along the Feather River below the Yuba River, and will provide moderate protection to 10,000 acres of land between the levees of the Yuba River. Protection also will be afforded 188,000 acres along the Feather River from Oroville to Marysville, through adjustment of operation of Oroville Dam. Except for the area between the levees, the degree of protection provided approximates or exceeds the Standard Project Flood (SPF).

d. Residual damages. - Residual damages are the average annual primary damages remaining under project conditions. They are computed in the same manner as preproject damages. Estimates of average annual residual damages with the Marysville Lake project in operation are summarized in the next tabulation.

AVERAGE ANNUAL RESIDUAL DAMAGES (1)
(In Thousands)

	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090	AVERAGE ANNUAL EQUIVALENT 1990-2090
REACHES 1-4								
Agriculture	$ 49.0	$ 63.4	$ 70.3	$ 78.0	$ 85.5	$ 93.7	$ 93.3	$ 79.7
Residential Structures	96.4	153.9	207.2	264.5	318.6	370.6	404.0	281.7
Residential Contents	43.5	68.3	91.2	115.8	139.3	162.0	176.6	123.5
(With Affluence)	(43.5)	(107.3)	(166.7)	(211.6)	(251.9)	(298.7)	(328.4)	(225.3)
Mobile Home Structures	10.5	15.2	19.6	24.2	28.7	33.2	36.2	25.8
Mobile Home Contents	3.8	5.4	6.9	8.5	10.1	11.6	12.7	9.1
(With Affluence)	(3.8)	(8.5)	(12.7)	(15.6)	(18.2)	(21.4)	(23.6)	(16.5)
Commercial	19.9	25.9	31.6	38.5	44.8	51.0	55.5	40.7
Industrial	1.5	2.3	2.9	3.4	3.9	4.5	5.0	3.6
Public & Semipublic Fac.	62.9	73.4	80.8	87.6	95.6	104.4	109.6	91.2
Emergency Costs	8.2	8.9	9.5	10.0	10.5	10.9	11.2	10.1
Sub-Total: Without Affluence	295.7	416.7	520.0	630.5	737.0	841.9	904.1	665.4
With Affluence	295.7	458.8	601.3	733.4	857.7	988.4	1,066.8	774.6
REACHES 5-8								
Agriculture	330.6	434.4	488.3	549.7	613.0	683.9	679.5	566.6
Residential Structures	671.9	982.3	1,304.2	1,608.7	1,737.1	1,831.6	1,868.5	1,540.4
Residential Contents	319.6	468.6	622.0	768.1	833.5	882.7	903.4	739.0
(With Affluence)	(319.6)	(736.2)	(1,137.5)	(1,410.4)	(1,515.1)	(1,640.0)	(1,690.1)	(1,352.6)
Mobile Home Structures	19.5	32.8	45.8	58.2	64.4	69.2	71.2	56.2
Mobile Home Contents	8.2	13.7	19.1	24.2	26.9	29.0	30.0	23.5
(With Affluence)	(8.2)	(21.6)	(34.7)	(44.4)	(49.0)	(53.9)	(56.0)	(43.0)
Commercial	174.9	232.2	276.7	325.7	372.3	420.1	453.9	342.8
Industrial	181.4	219.8	246.6	274.0	298.0	320.3	331.7	279.5
Public & Semipublic Fac.	136.4	184.7	221.4	254.3	288.6	321.3	338.4	265.1
Emergency Costs	312.8	318.0	322.3	325.5	326.6	327.4	328.0	324.5
Sub-Total: Without Affluence	2,155.3	2,886.5	3,546.4	4,188.4	4,560.4	4,885.5	5,004.6	4,137.6
With Affluence	2,155.3	3,162.0	4,077.5	4,850.9	5,264.1	5,667.7	5,817.3	4,770.7
REACHES 9-13								
Agriculture	477.0	688.0	802.7	938.5	1,063.5	1,206.4	1,203.9	967.0
Residential Structures	146.2	231.4	286.5	351.1	434.6	520.3	580.3	393.9
Residential Contents	159.9	254.6	315.9	387.8	480.4	575.3	641.5	435.0
(With Affluence)	(159.9)	(400.1)	(580.8)	(713.4)	(863.3)	(1,058.3)	(1,190.6)	(793.6)
Commercial	36.2	49.8	58.8	68.8	78.5	88.4	95.4	72.4
Industrial	28.6	33.0	36.3	39.4	42.3	44.8	45.8	40.0
Public & Semipublic Fac.	39.3	52.1	62.8	72.6	81.5	89.3	94.8	74.8
Emergency Costs	40.6	43.0	44.2	45.4	46.9	48.2	49.0	46.0
Sub-Total: Without Affluence	927.8	1,351.9	1,607.2	1,903.6	2,227.7	2,572.7	2,710.7	2,029.1
With Affluence	927.8	1,497.4	1,872.1	2,229.2	2,610.6	3,055.7	3,259.8	2,387.7
Total: Without Affluence	3,378.8	4,655.1	5,673.6	6,722.5	7,525.1	8,300.1	8,619.4	6,832.1
Total: With Affluence	3,378.8	5,118.2	6,550.9	7,813.5	8,732.4	9,711.8	10,143.9	7,933.0

(1) 1976 prices at 3-½ percent interest rate.

e. Inundation reduction benefits, "last added" analysis. - Inundation reduction benefits consist of a reduction in primary flood damages. These benefits are evaluated as the difference between preproject (existing conditions) and residual damages and are estimated to be $5,563,700 for the Marysville Lake project at 3-1/4 percent interest rate, as summarized in the next tabulation. In this analysis, preproject conditions are based on Oroville and New Bullards Bar Dams being in operation, and Marysville Lake project as the "last added" project for project conditions. Since the Marysville Lake project was developed as an integral part of a three-dam system, benefits were also evaluated on a system basis, as discussed in paragraph 61j; average annual flood damage reduction benefits on a system basis total $16,566,000 based on a 3-1/4 percent interest rate.

INNUNDATION REDUCTION BENEFITS, "LAST ADDED" ANALYSIS (1)

(In Thousands)

	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090	AVERAGE ANNUAL EQUIVALENT 1990-2090
REACHES 1-4								
Agriculture	$ 110.2	$ 137.7	$ 151.6	$ 167.0	$ 182.6	$ 199.5	$ 198.6	$ 170.9
Residential Structures	279.2	414.8	542.1	677.8	797.8	911.6	984.3	710.5
Residential Contents	127.5	188.0	244.9	305.6	359.6	411.3	444.7	320.7
(With Affluence)	(127.5)	(295.4)	(448.5)	(558.6)	(650.9)	(759.8)	(827.4)	(585.8)
Mobile Home Structures	27.5	38.9	49.1	60.0	70.3	80.3	87.1	63.3
Mobile Home Contents	10.6	14.5	18.1	22.0	25.6	29.2	31.6	23.2
(With Affluence)	(10.6)	(22.8)	(33.3)	(40.2)	(46.3)	(53.9)	(58.8)	(42.4)
Commercial	104.0	131.6	151.1	172.9	190.9	205.9	216.3	176.5
Industrial	82.5	95.1	104.5	112.7	117.4	120.5	123.1	111.8
Public & Semipublic Fac.	241.7	268.3	287.0	302.9	321.5	339.6	350.3	310.2
Emergency Costs	22.5	24.2	25.9	27.2	28.3	29.3	29.8	27.4
Sub-Total: Without Affluence	1,005.7	1,313.1	1,574.3	1,848.1	2,094.0	2,327.2	2,465.8	1,914.5
With Affluence	1,005.7	1,428.8	1,793.1	2,119.3	2,406.0	2,700.4	2,875.7	2,198.8
REACHES 5-8								
Agriculture	188.9	245.7	275.4	309.1	344.1	383.2	380.9	318.5
Residential Structures	380.5	554.6	736.8	908.2	975.9	1,024.1	1,040.9	865.4
Residential Contents	203.6	297.5	395.7	488.5	527.0	555.0	565.5	467.0
(With Affluence)	(203.6)	(467.5)	(723.5)	(896.9)	(958.8)	(1,031.7)	(1,058.3)	(854.9)
Mobile Home Structures	11.8	20.0	28.2	36.0	39.2	41.7	42.5	34.3
Mobile Home Contents	4.9	8.3	11.5	14.8	16.2	17.3	17.6	14.1
(With Affluence)	(4.9)	(12.9)	(21.1)	(27.0)	(29.5)	(32.0)	(33.0)	(25.9)
Commercial	106.0	140.9	168.0	197.8	226.0	255.0	275.4	208.0
Industrial	96.4	116.7	130.9	145.6	158.3	170.0	176.1	148.4
Public & Semipublic Fac.	80.2	107.0	127.6	146.3	165.8	184.1	193.6	152.4
Emergency Costs	255.6	258.9	261.8	263.9	264.5	265.0	265.2	263.2
Sub-Total: Without Affluence	1,327.9	1,749.6	2,135.9	2,510.2	2,717.0	2,895.4	2,957.7	2,471.3
With Affluence	1,327.9	1,924.2	2,473.3	2,930.8	3,162.1	3,386.8	3,465.9	2,871.0
REACHES 9-13								
Agriculture	34.5	46.8	52.4	58.6	64.6	71.2	70.6	59.9
Residential Structures	44.7	71.4	88.5	108.1	134.1	160.9	179.8	121.7
Residential Contents	52.7	84.3	104.6	127.7	158.6	190.4	212.9	143.9
(With Affluence)	(52.7)	(132.4)	(192.3)	(235.0)	(284.8)	(351.4)	(396.4)	(263.0)
Commercial	8.6	15.9	20.3	24.9	29.0	35.9	38.7	26.9
Industrial	2.6	3.1	3.5	4.0	4.4	4.7	4.8	4.0
Public & Semipublic Fac.	6.1	8.2	10.8	12.9	15.1	16.9	18.2	13.5
Emergency Costs	3.2	4.0	4.3	4.7	5.1	5.5	5.8	4.9
Sub-Total: Without Affluence	152.4	233.7	284.4	340.9	410.9	485.5	530.8	374.8
With Affluence	152.4	281.8	372.1	448.2	537.1	646.5	714.3	493.9
Total: Without Affluence	$2,486.0	$3,296.4	$3,994.6	$4,699.2	$5,221.9	$5,708.1	$5,954.3	$4,760.6
Total: With Affluence	$2,486.0	$3,634.8	$4,638.5	$5,498.3	$6,105.2	$6,733.7	$7,055.9	$5,563.7

(1) 1976 prices at 3-1/4 percent interest rate.

f. <u>Standard project flood event</u>. - The probable preproject and residual damages that would result from an SPF event are summarized in the next tabulation, derived from a "last added" analysis. It is estimated that Marysville Lake would reduce damages from an SPF event under existing conditions from about $345.2 million to about $9.3 million. About 44 percent of the $9.3 million residual damages would be agricultural damages, and about 48 percent would be damages to public facilities, including levee repair and flood fighting costs and damages to roads and bridges.

STANDARD PROJECT FLOOD
"Last added" analysis - 1976 Prices
(in thousands)

REACH	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090
			PREPROJECT DAMAGES				
1	9,700	10,784	11,360	11,805	12,354	13,092	13,316
2	3,266	6,047	7,915	9,472	10,912	12,603	13,458
3	53,985	92,600	128,027	160,951	191,752	223,605	243,933
4	0	0	0	0	0	0	0
5	29,768	49,024	64,410	79,111	93,006	108,396	115,139
6	6,398	8,110	9,188	10,301	11,628	13,149	13,369
7	221,589	360,475	496,893	604,425	642,189	675,561	686,094
8	12,965	16,502	18,602	20,593	22,827	25,390	26,139
9	540	869	1,094	1,329	1,557	1,795	1,953
10	3,447	5,205	6,338	7,538	8,673	9,984	10,248
11	16	19	22	24	26	28	29
12	374	441	476	513	546	581	587
13	3,137	5,544	7,136	8,470	10,117	12,094	13,271
TOTAL	345,185	555,620	751,461	914,532	1,005,587	1,096,278	1,137,536
			RESIDUAL DAMAGES				
1	2,963	3,180	3,289	3,378	3,482	3,617	3,643
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	195	224	249	272	295	316	328
6	1,213	1,213	1,213	1,213	1,213	1,213	1,213
7	0	0	0	0	0	0	0
8	1,400	1,537	1,611	1,695	1,779	1,872	1,872
9	156	114	89	64	45	39	39
10	2,312	3,292	3,876	4,571	5,212	5,947	5,960
11	0	0	0	0	0	0	0
12	256	301	324	349	371	394	399
13	827	1,136	1,283	1,444	1,602	1,774	1,780
TOTAL	9,322	10,997	11,934	12,986	13,999	15,172	15,234

g. Reduction in floodproofing costs. - When a structural plan negates the need for floodproofing measures that would be expected to be implemented in the absence of the plan, the cost of such floodproofing measures (less any increase in residual damages) is part of the inundation reduction benefit. It is assumed, as a preproject condition, that all new and replacement structures in Reach 1 would be constructed in compliance with the special encroachment provisions for the Yuba River previously discussed. The following data were used to develop the cost of floodproofing measures for the 1990-2090 period. Floodproofing costs that would be incurred prior to project completion are not considered as a project benefit.

Category	Structural Area (square feet)	Pad Height (feet)	Unit Cost 1/
Residential	1300	1	$ 200
Commercial	2000	2	615
Industrial	6500	2	1840

1/ Cost includes labor and equipment only, assuming the use of on-site materials for construction of floodproofing pads.

The average annual equivalent costs of nonstructural measures were derived from the above data and the projected timing of construction of new and replacement units for the Reach 1 area. Based on a 3-1/4 percent interest rate, the average annual equivalent cost of nonstructural measures is estimated to be $2,330 for the 1990-2090 period. With Marysville Lake, average annual equivalent residual damages for this period are estimated to be $111,610 and $123,630, respectively, with and without continuance of the

encroachment provisions. Since the increase in residual damages, $12,020, exceeds the estimated cost of providing floodproofing, $2,330, it is irrational to assume discontinuance of the encroachment provisions. The residual damages used in the estimate of inundation reduction benefits, therefore, assume continuation of these provisions and reduction in floodproofing costs is not considered as a project benefit.

h. Location and intensification benefits. - Location and intensification benefits accrue when decisions to locate new activities or to modify operations of existing activities result directly from implementation of a flood plain management plan. Such decisions are affected by perceptions of the land use decisionmaker regarding impact of the plan on the existing flood hazard.

Marysville Lake is the last increment of a system of three reservoir projects authorized to provide flood protection to the Feather and Yuba River flood plains. The completed Oroville Dam on the Feather River and New Bullards Bar Dam on the North Yuba River will significantly reduce streamflows in the event of 100-year storms or more frequent events. The 100-year flood is the event having the most significant impact on perception of flood hazard in land use decisions. Completion of the three-dam system by the construction of Marysville Lake would primarily provide additional protection from less frequent but more catastrophic flood events.

Completion of the Marysville Lake project would result in reduced Feather River flows between Oroville and the mouth of the Yuba River during

200-year or less frequent events and below the mouth of the Yuba River during about the 185-year or less frequent events. Such flow reductions would not be expected to significantly alter future land use decisions in these areas.

On the Yuba River, areas protected by existing project levees (damage reaches 2 and 3) currently have 100-year flood protection when freeboard is considered, and the Marysville Lake project is not expected to significantly affect future land use decisions in areas having such protection. Marysville Lake would, however, reduce the area inundated by the 100-year and more frequent events in the area along the Yuba River between the existing project levees, damage reach 1. Based on information contained in the 1968 Flood Plain Information Report prepared by the Corps of Engineers for this area, it is estimated that Marysville Lake would reduce the area inundated by the 100-year event by approximately 1,000 acres. However, most of this acreage is currently developed to orchards, and the area is expected to remain primarily in agriculture even with construction of the Marysville Lake project. Significant changes in land use thus would not be expected as a result of the project.

Based on the foregoing, it is concluded that Marysville Lake would not significantly affect projected land use or economic development in either the Feather River or Yuba River flood plain. Development previously described for without project conditions is expected with the project, and no location benefits or intensification benefits are expected to accrue.

i. Summary of flood control benefits, "last added" analysis. - Estimates of flood control benefits derived in the preceding subparagraphs on a "last added" basis are summarized in the next tabulation.

Marysville Lake Summary of Benefits
1976 Prices

	3-1/4%	6-3/8%
Inundation reduction benefits		
Existing (1976) conditions	$2,486,000	$2,436,000
Base Year (1990) conditions	3,634,800	3,634,800
Average annual equivalent benefits (1990-2090)	5,563,700 1/	5,003,600 2/
Reduction in floodproofing costs	0	0
Location and intensification benefits	0	0

1/ Rounded to $5,600,000.
2/ Rounded to $5,000,000.

j. Alternative system analysis. - Marysville Lake is the last increment of a system of three reservoirs authorized to provide flood protection to the Feather and Yuba Rivers flood plains, including Lake Oroville on the Feather River and New Bullards Bar on the North Yuba River.

In the system analysis, total system benefits are computed as the difference in flood damages without and with the flood control storage provided by all three reservoirs, and total benefits are allocated to the reservoirs on the basis of their effective flood control storage, which is based on their location within the river system.

Under the system analysis, benefits accruing in the Feather River flood plain between Oroville and the Yuba River are allocated to Lake Oroville; benefits accruing in the Feather River flood plain below the Yuba River are allocated between all three reservoirs on the basis of effective flood control storage; and benefits accruing in the Yuba River flood plain are allocated between Marysville Lake and New Bullards Bar on the basis of effective flood control storage. The percent allocation for the individual reservoirs, for the three flood plains, based on effective storage, are summarized in the following tabulation. This allocation served as the basis for allocation of system benefits.

Flood plain reach	Percent allocation of total benefits		
	Oroville	Marysville	New Bullards Bar
Yuba River	0	65	35
Feather River above Yuba River	100	0	0
Feather River below Yuba River	65	23	12

Source: Review Report Yuba River Basin, California, 31 October 1963, U.S. Army Corps of Engineers.

Estimates of preproject and residual damages and system benefits for the Yuba River and the Feather River below the Yuba River are summarized in the following tabulations. Benefits are not included for the Feather River above the mouth of the Yuba River since the Marysville Lake project did not contribute to benefits in that reach as the system benefit allocation was originally set up.

DAMAGES AND BENEFITS, SYSTEM ANALYSIS (1) (2)

(In Thousands)

	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090	AVERAGE ANNUAL EQUIVALENT 1990-2090
WITHOUT AFFLUENCE								
PREPROJECT DAMAGES								
Yuba River	$ 4,068.3	$ 5,789.4	$ 7,194.4	$ 8,897.7	$10,408.6	$11,872.2	$12,778.5	$ 9,371.1
Feather River below Mouth of Yuba	19,990.0	27,506.2	34,429.0	41,122.9	44,791.7	47,918.2	49,052.2	40,394.4
RESIDUAL DAMAGES								
Yuba River	295.7	416.7	520.0	630.5	737.0	841.9	904.1	665.4
Feather River below Mouth of Yuba	2,155.3	2,886.5	3,546.4	4,188.4	4,560.4	4,885.5	5,004.6	4,137.6
BENEFITS								
Yuba River	3,772.6	5,372.7	6,674.4	8,267.2	9,671.6	11,030.3	11,874.4	8,705.7
Feather River below Mouth of Yuba	17,834.7	24,619.7	30,882.6	36,934.5	40,231.3	43,032.7	44,047.6	36,256.8
WITH AFFLUENCE ON RESIDENTIAL AND MOBILE HOME CONTENTS ONLY								
PREPROJECT DAMAGES								
Yuba River	4,068.3	6,447.9	8,563.4	10,499.7	12,282.9	14,138.5	15,287.0	11,067.7
Feather River below Mouth of Yuba	19,990.0	30,700.0	40,592.1	48,809.2	52,923.8	56,909.3	58,372.2	47,707.2
RESIDUAL DAMAGES								
Yuba River	295.7	458.8	601.3	733.4	857.7	988.4	1,066.8	774.6
Feather River below Mouth of Yuba	2,155.3	3,162.0	4,077.5	4,850.9	5,264.1	5,667.7	5,817.3	4,770.7
BENEFITS								
Yuba River	3,772.6	5,989.1	7,962.1	9,766.3	11,425.2	13,150.1	14,220.2	10,293.1
Feather River below Mouth of Yuba	17,834.7	27,538.0	36,514.6	43,958.3	47,659.7	51,241.6	52,554.9	42,936.5

(1) For Yuba River flood plain and Feather River flood plain below mouth of Yuba River.

(2) 1976 prices at 3-1/4 percent interest rate.

SYSTEM BENEFITS ALLOCATED TO MARYSVILLE LAKE PROJECT

(In Thousands)

	EXISTING CONDITIONS	1990	2000	2010	2020	2030	2040-2090	AVERAGE ANNUAL 1/ EQUIVALENT 1990-2090
WITHOUT AFFLUENCE								
Yuba River	$2,452.2	$ 3,492.3	$ 4,338.4	$ 5,373.7	$ 6,765.6	$ 7,716.9	$ 8,306.0	$ 6,091.2
Feather River below Mouth of Yuba	4,102.0	5,662.5	7,103.0	8,494.9	9,253.2	9,897.5	10,130.9	8,339.1
TOTAL	6,554.2	9,154.8	11,441.4	13,868.6	16,018.8	17,614.4	18,436.9	14,430.3 2/
WITH AFFLUENCE ON RESIDENTIAL AND MOBILE HOME CONTENTS ONLY								
Yuba River	2,452.2	3,892.9	5,175.4	6,348.1	7,426.4	8,547.6	9,243.1	6,690.5
Feather River below Mouth of Yuba	4,102.0	6,333.7	8,398.4	10,110.4	10,961.7	11,785.6	12,087.6	9,875.4
TOTAL	6,554.2	10.226.6	13,573.8	16,458.5	18,388.1	20,333.2	21,330.7	16,565.9 3/

1/ At 3-1/4% interest rate.
2/ At 6-3/8% interest rate, the estimate is $12,634.3.
3/ At 6-3/8% interest rate, the estimate is $14,714.1.

The average annual flood control benefits allocated to Marysville Lake on the system basis are estimated to be $16,566,000, based on a 3-1/4 percent interest rate. These benefits compare with average annual benefits of $5,564,000 computed on a "last added" basis and are shown for comparative purposes only; they were not used for justification of the Marysville Lake project in the Phase I General Design Memorandum. The effect of using a system analysis on the benefit-cost ratio for the project is shown in the following tabulation. (Total project benefits are summarized in paragraph 65.)

	3-1/4 Percent	6-3/8 Percent
Annual costs	$51,000,000	$87,300,000
Total project benefits 1/		
Includes last added analysis	113,400,000	108,400,000
Includes system analysis	124,400,000	119,400,000
Benefit-cost ratio		
Includes last added analysis	2.2	1.2
Includes system analysis	2.4	1.4

1/ Excludes costs of road betterments, cultural resources preservation, and relocations assistance.

k. Impact on Bear River. - Portions of damage reaches 3, 5 and 6 are subject to flooding by the Bear River as well as by the Feather and Yuba Rivers. However, since the probability of simultaneous flooding by the Bear River and the Yuba or Feather Rivers is very rare and since Marysville Lake is not expected to have a significant impact on the Bear River flood problem, such flooding is considered to be beyond the scope of this report. A detailed discussion of the Bear River flood problem is contained in the Bear River-California Feasibility Report for Water Resources Development, September 1972 prepared by the Corps of Engineers.

62. Recreation benefits. -

a. Recreation needs and projected project use. - Studies indicate there is a significant need for lake-oriented recreation opportunities and recreation opportunities associated with free-flowing streams. The Marysville Lake project has the potential for providing recreation opportunities at the lake and along the lower Yuba River, from the afterbay dam downstream to the mouth. However, due to lack of non-Federal participation in cost sharing for recreation at the lake, the project would provide for only minimum recreation facilities to protect public health and safety at the lake and less than optimum development in the Yuba River corridor due to financial limitation of Yuba County, the local sponsor. Recreation use associated with optimum and selected recreation development is compared in the next tabulation.

		Use (1,000 recreation days)			
		General Recreation		Fish and wildlife recreation recommended	
	Year	Optimum	Recommended	Hatchery	Hunting
Marysville Lake	1990	350	70	15	5
	1993	390	150	100	5
	2040	600	150	150	5
	2090	1,000	150	200	10
Lower Yuba River	1990	130	95	-	-
	1993	140	100	-	-
	2040	235	170	-	-
	2090	400	300	-	-

b. Recreation benefits. - Recreation benefits associated with the recommended plan are as follows:

	Average annual net benefits	
	3-1/4%	6-3/8%
Marysville Lake		
General recreation	$209,000	$197,000
Specialized recreation	244,000	184,000
Total	$453,000	$381,000
Lower Yuba River		
General recreation	97,000	84,000
Specialized recreation	318,000	266,000
Total	$415,000	$350,000
Total Net Benefits	$868,000 (a)	$731,000 (b)

(a) Rounded to $900,000
(b) Rounded to $700,000

Derivation of recreation benefits is discussed in detail in Appendix D, Recreation Resources.

63. Enhancement of fish and wildlife. -

a. Fishery enhancement measures. - Anadromous fishery enhancement measures to be implemented as a part of the Marysville Lake project include:

- Hatchery to provide enhancement runs of 50,000 salmon and 10,000 steelhead.

- Stream gravel management and construction of a spawning side channel to provide enhancement runs of 20,000 salmon.

Other enhancement measures would be taken for the fishery in Marysville Lake, including leaving vegetation in place in selected areas to provide habitat, reservoir management to minimize lake fluctuation during early summer spawning period, fish restocking, and rough-fish eradication programs.

b. Fishery enhancement benefits. - With a hatchery and associated fish facilities (gravel management and a special spawning channel) downstream of the afterbay, it is expected that the river fishery can be enhanced by 10,000 spawning steelhead and 70,000 spawning salmon. In the case of steelhead, it is expected that a 10,000 increase would provide 1,000 more fish each year for catching by sport anglers on the Yuba, Feather, and Sacramento River system. Based on an estimate of 10 recreation days of use expended for each fish caught, the recreation value of the 1,000 fish increase is:

$$1{,}000 \text{ fish} \times \frac{10 \text{ rec days}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$60{,}000$$

The 70,000 salmon that would be added to the river system would produce 280,000 mature fish, and the value to the commercial fishery is:

$$147{,}000 \text{ fish} \times \frac{10 \text{ lbs}}{\text{fish caught}} \times \frac{\$2.00}{\text{lb}} = \$2{,}940{,}000;$$

the recreation value of ocean sport fishing is:

$$56{,}700 \text{ fish} \times \frac{1 \text{ rec day}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$340{,}000;$$

and the recreation value of inland sport fishing is:

$$6{,}300 \text{ fish} \times \frac{10 \text{ rec days}}{\text{fish caught}} \times \frac{\$6.00}{\text{rec day}} = \$378{,}000$$

Fishery enhancement benefits are summarized in the following tabulation:

Species	Enhancement (Number of spawning fish)	Value (Benefits)
Steelhead	10,000	$ 60,000
Salmon	70,000	3,658,000
Ocean commercial		(2,940,000)
Ocean sport		(340,000)
Inland sport		(378,000)
Total		$3,718,000 [a]

(a) Rounded to $3,700,000.

64. Area redevelopment. -

The Area Redevelopment Act, Public Law 87-27, 87th Congress, 1st Session, and its successor, the Public Works and Economic Development Act of 1965, Public Law 89-136, 89th Congress, provide for the Federal Government to cooperate with the states to help areas of substantial and persistent unemployment and underemployment, and to take effective steps in planning and financing their economic development. Federal assistance should enable such areas to enhance their domestic prosperity by creation of new employment opportunities through development and expansion of new and existing facilities and resources. The role of the Corps of Engineers

in this program is set forth in ER 1165-2-6, dated 1 February 1966, which also specifies criteria to be used for project formulation and evaluation. The ER states that, in addition to the criteria now in use, estimates of benefits may include an amount equivalent to that part of the construction costs which represents wages to workers who, in the absence of the project, would be unemployed. Yuba and Sutter Counties are designated as eligible for assistance under the administration of the U.S. Department of Commerce.

Yuba and Sutter Counties are principally engaged in agricultural production, but food processing, mining, and lumber industries contribute significantly to their economy. Major industrial activities directly connected with agricultural, lumber, and mineral production include milk and food processing plants, canneries, plant nurseries, lumber mills, and related manufacturing of wood products. The diversification of processing plants, mill operations related manufacture of mining products, and the relative stability of the printing and publishing industries tend to reduce seasonal unemployment; however, production of agricultural commodities, cutting and handling of timber, and production of minerals are seasonal occupations with high off-season unemployment. A large percentage of the workmen of these seasonal industries maintain homes in the area, thus forming a labor supply for which there is limited year-round employment opportunity. Increasing automation has eliminated some jobs in the various industries and their related products.

The labor force, for purposes of this analysis, is grouped into two major categories, unemployed labor and labor provided by the project. In July 1975, the unemployment rate for Yuba and Sutter Counties was 13.6

percent. County unemployment records indicate that of the unemployed, 20 percent are skilled; 35 percent are semiskilled; and 45 percent are unskilled. Historical analysis of construction projects in California, similar to Marysville Lake, indicate that labor requirements for construction include 40 percent skilled, 30 percent semiskilled and 30 percent unskilled labor. Based on prevailing wage rates, about 14,500 jobs will be created during the 9-year project construction period.

A comparison of the current unemployed in Yuba and Sutter Counties and peak year project construction labor requirements is shown in the following tabulation.

	Sutter & Yuba Counties Unemployed	Estimated Peak Year Local Job Requirements
Skilled	835	560
Semiskilled	1,461	510
Unskilled	1,879	510
Total	4,175 1/	1,580

1/ July 1975, State of California Employment Development Dept.

a. Methodology. - Benefits to the project are equivalent to wages paid for workers who, in the absence of the project, would most likely be unemployed. Evaluation of costs for similar construction projects in California indicates that about 35 percent of the total Federal construction costs represents the total labor requirement of the project for construction. Of total labor costs, it was estimated that local labor costs were 45 percent. Therefore, the project would provide the equivalent of about 6,500 man-years of work for local unemployed labor during the 9-year construction phase.

b. Benefits. - Area redevelopment benefits creditable to the Marysville Lake project amount to $5,000,000, based on 3-1/4 percent interest rate, and $10,700,000, based on 6-3/8 percent interest rate, (October 1976 price levels). Details of the derivation are shown in the next tabulation.

	3-1/4%	6-3/8%
Total construction cost 1/	$818,900,000	$818,900,000
Estimated labor cost (35% x $818,900,000)	286,615,000	286,615,000
Labor cost assigned depressed area (45% x $286,615,000)	128,976,750	128,976,750
Construction period: 9 years		
Average value per year ($128,976,750/9)	14,330,750	14,330,750
Value of assigned labor cost at end of 9 years ($14,330,750 x 11.597)	147,076,500	
($14,330,750 x 13.416)		167,268,500
Average Annual equivalent benefits ($147,076,500 x .03388)	4,982,950 2/	
($167,268,500 x .06389)		10,686,800 3/

1/ Excludes land, engineering and design, and supervision and administration.
2/ Rounded to $5,000,000.
3/ Rounded to $10,700,000.

65. Summary of benefits. - Average annual benefits for the selected plan, discussed in the foregoing paragraphs are summarized below:

	3-1/4 percent	6-3/8 percent
Power 1/	$ 88,100,000	$ 77,500,000
Irrigation water supply	10,100,000	10,800,000
Flood damage reduction 2/	5,600,000	5,000,000
Recreation	900,000	700,000
Anadromous fishery enhancement	3,700,000	3,700,000
Total without ARA	$ 108,400,000	$ 97,700,000
Area redevelopment	5,000,000	10,700,000
Total with ARA	$ 113,400,000	$ 108,400,000

1/ At site.
2/ Last added analysis.

66. Other effects of project. - This paragraph discusses economics, social and other project effects, including relocations, and effects on public services. The location of county services is shown on Figure K-3.

a. Economic effects. - The Marysville Lake project would cause changes in the economy of the local area and Yuba County. The project would lessen expenditures to prevent and/or repair flood damages to the Marysville-Yuba City urban area and nearby agricultural areas. The project could provide monthly reregulation of local irrigation water, making it possible for the local irrigation service areas to develop a conjunctive program for use of ground and surface water, and could result in intensifying agricultural practices in the county.

The project would remove about 2.2 percent of Yuba County's assessed valuation ($2.2 million of $100 million), as shown in the next tabulation, and 6.6 percent of the county's assessable land area (19,560 acres of 297,600) from the tax rolls. However, based on experience at other projects, it is anticipated that private development around the project area would be allowed by local government and would compensate for the loss of assessables incurred by construction of the project. Removal of the project area from the assessment rolls of other taxing authorities in Yuba County will also reduce their revenues, as shown in the next tabulation. In addition, the project would remove 3,000 acres of land (Hackett Creek area) from Nevada County's assessed valuation. Under Public Law 94-565, the Federal Government would make an annual payment for the duration of the project life to Yuba and Nevada Counties in lieu of taxes of $0.75 per acre for lands on the tax rolls required for the project.

TAX RATES AND ASSESSED VALUATIONS BY DISTRICT 1/
(1975 - 1976 FISCAL YEAR)

Tax District	Assessed Value per Tax District	Assessed Valuation Within Project Area	% Loss	Tax Rate/ $ 100	Tax Loss
County	$ 99,812,064	$2,153,000	2.2	$3.85	$82,890
Marysville Joint Unified School District	$ 82,683,789	$2,153,000	2.6	$4.30	$92,580
Yuba County Water Agency	$ 99,812,064	$2,153,000	2.2	$0.08	$ 1,720
Yuba County Community College	$452,622,249	$2,153,000	0.5	$1.00	$21,530

Source: Conversations with Yuba County Auditor and Superintendent of Schools.

1/ Fiscal 1974-75 assessment; fiscal 1975-76 rate. The college tax district extends outside the boundaries of Yuba County.

The Marysville Lake project would inundate the existing PG&E Narrows I and YCWA Narrows II Powerplants. Narrows I Powerplant has an installed capacity of 9 MW, and Narrows II Powerplant has an installed capacity of 47 MW. The plants generate in the order of 51 and 224 million kWh annually, respectively.

Data on jobs expected to be lost or displaced due to project construction are not readily available, but such losses are expected to be minor. The project would have a significant effect on employment opportunities in the local area during the construction phase. The estimated number of jobs to be created during the construction period is given in the following tabulation. The maximum number of workers joining the construction crew from outside the Sutter-Yuba County area is estimated

to number about 1,580 or 5.2 percent of the 30,625 labor force for the two-county area. During the peak year of construction, the project would provide jobs for an estimated maximum of 1,935 local workers, and a lesser number of jobs in other years in the construction period, with some beneficial impact on the area's chronic unemployment problem. About 13.6 percent of the labor force is now unemployed.

CONSTRUCTION SITE LABOR IMPACTS

	Construction Year								
	1981-1982	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	1989-1990
Distribution of jobs, percent1/	1.1	3.9	8.9	11.9	13.8	24.3	19.2	10.9	5.8
Total on site jobs	150	570	1,300	1,730	2,010	3,520	2,780	1,580	850
New workers to area2/	70	255	585	780	905	1,585	1,250	710	380
New population3/	210	765	1,755	2,340	2,715	4,755	3,750	2,130	1,140
New students4/	50	80	410	550	635	1,110	875	500	270
Projected number of district students plus new students5/	15,902	15,965	16,336	16,536	16,686	17,228	17,061	16,762	16,608
New students as percent of projected number	0.3	0.5	2.6	3.4	4.0	6.9	5.4	3.1	1.7

1/ Based on studies of project construction costs versus average annual heavy equipment operator cost of $26,400 per job and average annual laborer cost of $17,600 per job.
2/ 45% of total jobs at construction site.
3/ New population is approximated by assuming three persons per new family.
4/ Assuming 0.7 school (k-12) children per family.
5/ Adapted from Yuba City and Marysville Joint Unified School District Master Plans.

Private development of recreation-related businesses near the project, such as concessions, restaurants, and stores, would provide job opportunities. Also, if the project induces substantial recreation-oriented residential development, new businesses would be established to serve such development and also would provide job opportunities.

The removal of project lands from county tax rolls could have a temporary adverse economic impact on the county. However, it is expected that there will be increased development on private lands around the project, similar to what has occurred at Oroville and Folsom Lake. This will not only offset losses to the tax rolls but will increase the tax base beyond the level presently projected without the project. Folsom Lake has had positive benefits for both Sacramento and El Dorado Counties. During construction there was no apparent loss in assessed valuation. Proximity of Folsom Lake to Sacramento probably accounts for the large increase in home construction and subdivision activity, with the accompanying increases in land values. The general pattern following reservoir construction in the Central Valley has been that adjacent land values have increased and that county and municipality assessed valuations have not declined; however, the specific effect depends on accessibility to population and employment centers. At New Bullards Bar Reservoir there was some increase in land values, reportedly as a result of speculation in recreational homesites, but there is no current residential development. There has not been a substantial increase in property values around Camp Far West Reservoir south of the project or Merle Collins Reservoir north of the project. Black Butte Lake, in Glenn and Tehama Counties, has had little impact on these

counties. However, there has been significant increase in land values and recreational homesite development in the vicinity of Auburn Dam currently under construction by the U.S. Bureau of Reclamation in Placer and El Dorado Counties. The Browns Valley Irrigation District (BVID) also would be affected by the project, since 14 percent of the irrigable land and 26 percent of the total land in the district would be acquired for the project.

Increased recreation activity on the river and adjacent lands would stimulate the economic climate of Yuba County.

As discussed in Appendix J, Water Resources and Irrigation Supply, implementation of the Marysville Lake project would require acquisition of 12,100 acres of land currently taxed by BVID, resulting in a revenue loss of an estimated $80,000 per year, and acquisition of two irrigation ditches to which BVID owns a perscriptive right. In addition, it appears BVID may lose part or all of their $74,000 payment for "falling water" rights. Project costs include reimbursement of BVID for the two irrigation ditches inundated. However, the loss of future revenue due to reduced assessed valuation and water sales is considered consequential damage and is not compensable.

The future production of aggregates and possibly precious metals from inundated tailings would be lost. However, 50 million cubic yards of earth and dredge tailings would be utilized to construct the embankments, with a large portion of the required aggregates coming from the tailings to be inundated. Further, some tailings would become

unavailable for aggregate production due to creation of the downstream Yuba River corridor, but it is estimated that after completion of the project more than 1,400 million tons (about 1,000 million cubic yards), of tailings would remain available downstream of the project.

b. Effects on U.C. Sierra Foothill Range Field Station. - The Field Station was established in 1960 on about 5,700 acres of land ranging in elevation from 300 to 2,000 feet with climate, soils, terrain, and vegetation typical of California foothill lands. The Field Station was originally established for research of beef cattle production and range improvement practices, but research activities have been broadened.

The Marysville Lake project would require acquisition of about 1,140 acres of the Field Station's lands for project purposes (740 acres inundated and 400 acres above gross pool for rights-of-way), reducing lands owned by the Field Station by about 20 percent. All research conducted on lands acquired by the Corps of Engineers would be terminated. Field Station personnel indicate this is a significant impact in that it would terminate on-going research projects and prevent future research projects in the areas acquired. It would also negate the value of these areas as contributing to the continuity of an on-going and permanent data base.

Approximately half (100 acres) of the irrigated pasture on Field Station lands would be acquired. An additional 100 acres of land to be

acquired has the potential to be developed into irrigated pasture. One hundred acres of the 170-acre natural area along the Yuba River would be acquired for the project.

The lower ditch which supplies 60 miner's inches would be inundated by the project.

Approximately 100 of the 170-acre natural area along the Yuba River would be acquired for the project. About 5 acres of aquatic habitat (year-round wet areas or bogs) where vector control and biological research is conducted, would be inundated. About 5 acres of dense stands of native bunch grass (Stipa and Melica spp), located along the steep canyon area near Timbuctoo Bend, are on lands required for the project.

c. Social effects. - Construction of the Marysville Lake project would change the land use and social characteristics in the project area. Approximately 160 dwelling units would be relocated or demolished. The Timbuctoo and Bridgeport Cemeteries and individual graves would be relocated. Current preliminary estimates indicated some 500 people, and 13 businesses would be relocated. For most people, the most obvious impact would be their change in residence. Those with jobs in Marysville/Yuba City could be faced with modifying their commuting patterns. Those moving into Marysville/Yuba City would find it necessary to adjust to city conditions,

but would benefit from closer proximity to employment. Relocated children would be confronted with new schools and social environments. Established social patterns and ties in general would be disturbed. School structure, busing routes, and other educational patterns and schedules would be changed. Clubs and organizations could experience some shifts in membership and activities. Some localized businesses could be affected by relocation.

The influx of new workers to the area during the construction of the project would have an impact on the housing market. At the peak of construction, an influx of as many as 1,210 workers and their families would require living quarters. Because of the low single-family-unit vacancy rate throughout the county, the incoming construction workers not utilizing mobile homes and the residents to be relocated would have an impact on the housing market in the surrounding communities. The relocation needs and desires of residents to be relocated would be analyzed in future detailed studies, and it is not possible at this time to make firm statements about the nature of the social impact. It can be expected, however, that the project might lead to temporary overcrowding in the communities in the project area.

If the lake becomes a popular recreation area, residential subdivisions can be expected to be developed outside the Federal property line, and population density in the area would increase. Much of the activity probably would take place in Smartville, immediately south of the lake and in the direction of Marysville, Browns Valley, and Loma Rica. Construction

of the dam is not expected to result in significantly increased population density in the flood plain because of the level of protection already provided to a majority of these lands by New Bullards Bar and Oroville Dams and levees of the Sacramento River Flood Control Project.

Project construction is expected to increase job opportunities for some county residents over the construction period. If the project induces substantial recreation-oriented residential development, people would probably be attracted to the area, particularly during the summer season, and some job opportunities with new businesses serving such development can be expected for Yuba County residents. Private development of concessions, restaurants, stores, and entertainment could result in an alteration of the rural, social, and visual environment now existing in local areas. Criminal incidents would be expected to increase because of additional use of the area.

d. <u>Schools</u>. - Construction of the project would not inundate any schools; however, the number of students in the Yuba City and the Marysville Joint Unified School District would increase as a result of the influx of construction workers for the project. A major portion of new students coming from project-attracted families will probably enroll in Marysville District schools, with a lesser number attending Yuba City District schools. The Marysville District is currently below maximum capacity and could absorb new students brought into the area by the project if they were spread across the entire district or concentrated near Marysville.[1/] Enrollment

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1/ During construction of New Bullards Bar Reservoir in 1968-69, an additional 500 students were accommodated by Marysville School District.

in the foothills area are expected to increase during the project life, even without the project construction, and some over-crowding could occur in these schools. The Yuba City District schools should have little trouble in accommodating the additional students. Financial assistance for new school construction and school programs may be available as a result of project construction under PL 815 and PL 874. The amount of assistance will depend on available Federal funding and local qualification which would be determined during the construction phase.[1/]

e. Transportation relocations. - The Marysville Lake project would submerge or make unusable about 7 miles of State Highway 20 and 17 miles of roads in Yuba and Nevada Counties, and relocation of these roads would be required to restore the road network in the area. A preliminary relocation alignment for State Highway 20 would be across the afterbay on a bridge upstream from the dam to the Hammonton-Smartville County Road, and over that road alignment back to the existing highway near Smartville. This relocated route is approximately the same length as the existing one. The optimum relocation is yet to be developed, but it is likely the relocated road would be generally safer than the existing highway. Approximately 39 acres of new right-of-way would need to be acquired for the relocated highway outside of project lands and existing county road right-of-way. The Peoria Road would be relocated to the west of the reservoir to provide a north-south connecting link in the county road network; the relocation would be approximately 2.5 miles long and require 16 acres of new right-of-way. The Pleasant Valley Road at Bridgeport would need to be relocated over

1/ Arnie Thorson, U.S. Office of Education, HEW, Region IX, San Francisco, 1975.

approximately 0.5 mile. The approach roads to the old covered bridge at Bridgeport would also be raised or relocated to suit the bridge relocation. A new road providing access to the U.C. Sierra Foothill Range Field Station has been tentatively proposed on the east side of the reservoir, extending approximately 6.7 miles south from its intersection with Dolan-Harding Road. The relocation of State Highway 20 and about 10 miles of county roads would result in a temporary small loss in tax revenue to the counties from commercial establishments. Appropriate relocation measures would be developed in design studies.

f. Utility relocations. - The Browns Valley main ditch siphon may require modification. The Smith Bar, Sicard Flat, and Ellis Ditches would be abandoned. The Farm Ditch on the south side of the project would be relocated, possibly parallel to the Ousley Ditch. Appropriate measures would be developed in design studies.

All waste materials in a former 24-acre solid waste disposal site, within a mile of the afterbay spillway, would be relocated to another disposal site at Beale AFB.

The increase in population during construction and residential development during operation and recreation use would increase solid waste generation in the project area. Liquid waste loads would be increased by recreationists to the project area and new residents brought to the area by dam construction. Sanitary facilities would be provided at all points of concentration of recreation use.

g. Public facilities. - The load on county health facilities would be heavier because of increased population, especially if recreational-residential development occurs. In addition, there would be a greater need for police and fire protection. The Yuba County police would probably need to increase personnel and equipment subsequent to completion of the project. All reasonable efforts would be made to prevent fires. Fire suppression equipment and personnel would be at the project area during construction. An overall plan for fire protection would be developed. Fire stations in the area would have to change their dispatch patterns due to changes in the present road system.

h. Cemeteries. - An estimated 100 gravesites in small cemeteries at Timbuctoo and Bridgeport and in scattered locations downstream of the afterbay and within the afterbay and lake areas would be relocated outside of the reservoir and spillway areas.

67. Project costs. -

The basis of estimates of first and annual costs and detailed cost estimates are presented in Appendix M, Detailed Cost Estimates.

a. First costs. - Project first costs are summarized in the following tabulation, based on 1 October 1976 price levels.

First Costs

Cost Acct. No.	Feature	Subtotal $	Total $
	STAGE I		
01.	LANDS AND DAMAGES		$ 39,200,000[a/]
02.	RELOCATIONS		22,100,000
	Roads & bridges	$ 21,400,000	
	Cemeteries & utilities	700,000	
03.	RESERVOIRS		7,160,000
04.	DAMS		531,300,000
	Yuba River Dam	290,900,000	
	Power intake works	65,900,000	
	Dry Creek Dam & dikes	95,900,000	
	Outlet works	4,400,000	
	Afterbay Dam	74,200,000	
06.	FISH AND WILDLIFE FACILITIES		15,500,000
07.	POWERPLANT		227,500,000
	Powerplant Yuba River Dam	215,200,000	
	Powerplant Afterbay Dam	12,300,000	
08.	ROADS		1,670,000
14.	RECREATION FACILITIES (Initial)		1,000,000
18.	CULTURAL RESTORATION & PRESERVATION		9,570,000
19.	BLDGS., GROUNDS, & UTILITIES		2,100,000
20.	P.O. EQUIPMENT		1,000,000
	SUBTOTAL		858,100,000
30.	ENGINEERING AND DESIGN		49,400,000
31.	SUPERVISION AND ADMINISTRATION		53,500,000[b/]
	TOTAL COST (FEDERAL) STAGE I		$961,000,000[c/]

a/ Excludes cost of Federal land to be transferred to the project. Estimated market value is $1,500,000.
b/ Excludes GSA-controlled bldg. space cost.
c/ Excludes future recreation costs.

First Costs (Cont'd)

Cost Acct. No.	Feature	Subtotal $	Total $
	STAGE II		
04.	DAMS		$ 23,100,000
	Power Intake Works	$ 12,900,000	
	Afterbay Dam	10,200,000	
07.	POWERPLANT		129,200,000
	Powerplant Yuba River Dam	127,900,000	
	Powerplant Afterbay Dam	1,300,000	
08.	ROADS		240,000
19.	BLDGS., GROUNDS, & UTILITIES		460,000
	SUBTOTAL		153,000,000
30.	ENGINEERING AND DESIGN		11,300,000
31.	SUPERVISION AND ADMINISTRATION	(a)	10,700,000
	TOTAL COST (FEDERAL) STAGE II		$175,000,000
	FUTURE RECREATION FACILITIES		
14.	RECREATION FACILITIES (FUTURE)		240,000
30.	ENGINEERING AND DESIGN		30,000
31.	SUPERVISION AND ADMINISTRATION	(a)	20,000
	TOTAL COST (FEDERAL) FUTURE RECREATION FACILITIES		$290,000

(a) Excludes GSA controlled bldg. space cost

First Costs (Cont'd)

Cost Acct. No.	Feature	Subtotal $	Total $
	TOTAL PROJECT		
01.	LANDS AND DAMAGES		$ 39,200,000 a/
02.	RELOCATIONS		22,100,000
	Roads & bridges	$ 21,400,000	
	Cemeteries & utilities	700,000	
03.	RESERVOIRS		7,160,000
04.	DAMS		554,400,000
	Yuba River Dam	290,900,000	
	Power intake works	78,800,000	
	Dry Creek Dam & dikes	95,900,000	
	Outlet works	4,400,000	
	Afterbay Dam	84,400,000	
06.	FISH AND WILDLIFE FACILITIES		15,500,000
07.	POWERPLANT		356,700,000
	Powerplant Yuba River Dam	343,100,000	
	Powerplant Afterbay Dam	13,600,000	
08.	ROADS		1,910,000
14.	RECREATION FACILITIES		1,240,000
	Initial	1,000,000	
	Future	240,000	
18.	CULTURAL RESTORATION & PRESERVATION		9,570,000
19.	BLDGS., GROUNDS, & UTILITIES		2,560,000
20.	P.O. EQUIPMENT		1,000,000
	SUBTOTAL		1,011,340,000
30.	ENGINEERING AND DESIGN		60,730,000
31.	SUPERVISION AND ADMINISTRATION		64,220,000 b/
	TOTAL PROJECT FIRST COST (FEDERAL)		$1,136,290,000

a/ Excludes cost of Federal land to be transferred to the project. Estimated market value is $1,500,000.

b/ Excludes GSA-controlled bldg. space cost.

	3-1/4%	6-3/8%
TOTAL EQUIVALENT FIRST COST		
Initial	$ 961,000,000	$ 961,000,000
Present Worth Future Power	127,100,000	94,300,000
Present Worth Future Recreation	100,000	50,000
TOTAL	$1,088,200,000	$1,055,350,000

b. Annual costs. - Project investment and annual costs are summarized in the following tabulation.

STAGE I

	3-1/4% Interest	6-3/8% Interest
INVESTMENT COST		
1. FEDERAL (Dam & Reservoir)		
a. First cost	$ 961,000,000	$ 961,000,000
b. Market value of Federal lands to be transferred to project	1,500,000	1,500,000
c. Interest during construction	85,969,000	168,632,000
(1) Yuba River Dam & Powerplant (7 yrs x 3-1/4% x 1/2 x 572,000,000 x 1.125)	(73,198,000)	(143,581,000)
(2) Dry Creek Dam (5 yrs x 3-1/4% x 1/2 x 100,300,000 x 1.125)	(9,168,000)	(17,983,000)
(3) Afterbay Dam & Powerplant (3 yrs x 3-1/4% x 1/2 x 65,700,000 x 1.125)	(3,603,000)	(7,068,000)
d. Gross (or net) investment	$1,048,469,000	$1,131,132,000

ANNUAL COST

2. FEDERAL (Dam & Reservoir)

a. Interest (3-1/4% x 1d)	$ 34,074,500	$ 72,109,500
b. Adjustment for loss of productivity of lands (0.0175 x 17,160,000)	238,000	NEG
c. Amortization (100 yrs @ 0.00138 x 1d)	1,447,000	158,000
d. Maintenance and operation Dam & Reservoir	7,412,500	7,288,500
e. Major replacements Dam & Reservoir	1,102,000	593,000
3. TOTAL ANNUAL COST, STAGE I	$ 44,274,000	$ 80,149,000

STAGE II

	3-1/4% Interest	6-3/8% Interest
1. INVESTMENT COST		
a. First cost	$ 175,000,000	$ 175,000,000
b. Interest during construction	8,047,000	15,785,000
(1) Yuba River Dam Powerplant 3 yrs x 3-1/4% x 1/2 x 1.145 x 127,900,000	(7,139,000)	(14,004,000)
(2) Afterbay Dam & Powerplant & Power Intake Works 2 yrs x 3-1/4% x 1/2 x 1.145 x 24,400,000	(908,000)	(1,781,000)
c. Gross (or net) investment	183,047,000	190,785,000
2. ANNUAL COST		
a. Interest (3-1/4% x 1c)	5,949,000	12,163,000
b. Amortization (100 yrs @ 0.00138 x 1c)	253,000	27,000
c. Maintenance and Operation	3,831,000	3,831,000
d. Major replacements	546,000	292,000
3. TOTAL ANNUAL COST (FEDERAL)	$ 10,579,000	$ 16,313,000

FUTURE RECREATION FACILITIES

	3-1/4% Interest	6-3/8% Interest
1. INVESTMENT COST		
a. First Cost	$ 290,000	$ 290,000
2. ANNUAL COST		
a. Interest (3-1/4% x 1a)	9,400	18,500
b. Amortization (100 years @ 0.00138 x 1a)	400	(Neg.)
c. Maintenance and operation	26,000	26,000
3. TOTAL ANNUAL COST (FEDERAL)	$ 35,800	$ 44,500

TOTAL PROJECT

	3-1/4% Interest	6-3/8% Interest
1. INVESTMENT COST		
a. First cost	$1,136,290,000	$1,136,290,000
b. Market value of Federal lands to be transferred to project	1,500,000	1,500,000
c. Interest during construction	94,016,000	184,417,000
d. Gross (or net) investment	$1,231,806,000	$1,322,207,000
2. ANNUAL COST		
a. Interest (3-1/4% x 1d)	$ 40,032,900	$ 84,291,000
b. Adjustment for loss of productivity of lands	238,000	NEG
c. Amortization	1,700,400	185,000
d. Maintenance and operation	11,269,500	11,145,500
e. Major replacements	1,648,000	885,000
3. TOTAL PROJECT ANNUAL COST (FEDERAL)	$ 54,932,800	$ 96,595,500

68. Benefit validation. -

a. Break-even years. - The project year in which undiscounted and discounted annual benefits first exceed annual charges is year one at 3-1/4 percent interest and year 10 at 6-3/8 percent interest, as shown on Figures K-4 and K-5.

b. Internal rate of return. - The rate of interest at which benefits equal costs over the period of analysis is 7.69 percent, as shown on Figure K-6.

SECTION X - SYSTEM OF ACCOUNTS

69. System of accounts. -

Principles and Standards and ER 1105-2-921 require that feasibility reports contain a display of the effects of the project on the four public information accounts: National Economic Development, Environmental Quality, Social Well-Being, and Regional Development. The System of Accounts display on the following pages includes only those beneficial and adverse impacts which were judged to be significant. Additional information on the entries in the display are contained elsewhere in this appendix and in the Phase I GDM and EIS.

SYSTEM OF ACCOUNTS

ACCOUNTS	NED PLAN			EQ PLAN			SELECTED PLAN		
PLAN DESCRIPTION	916,000 acre-foot reservoir at Parks Bar site, and 80,800 acre-foot afterbay; 2250 MW pumped-storage peaking powerplant at main dam, and 15 MW baseload powerplant at afterbay day; fish hatchery and other measures to provide escapement of 70,000 salmon and 10,000 steelhead; 4 initial plus 2 future recreation areas and trail system along lower Yuba River; optimum-level recreation plan at lake; 14,350 acres for preservation and improvement of riparian vegetation and fish and wildlife habitat.			514,000 acre-foot reservoir at Parks Bar site, dike between Yuba River and Dry Creek, and 18,600 acre-foot afterbay; 100 MW conventional peaking powerplant at main dam, and 15 MW baseload powerplant at afterbay dam; fish hatchery and other measures to provide escapement of 70,000 salmon and 10,000 steelhead; 4 initial plus 2 future recreation areas and trail system along lower Yuba River; optimum-level recreation plan at lake; about 11,000 acres for preservation and improvement of riparian vegetation and fish and wildlife habitat.			916,000 acre-foot reservoir at Parks Bar site, and 80,800 acre-foot afterbay; 2250 MW pumped-storage peaking powerplant (1350 MW initial installation and 900 MW added in year 2000); 15 MW baseload powerplant at afterbay dam; fish hatchery and other measures to provide escapement of 70,000 salmon and 10,000 steelhead; 4 initial plus 2 future recreation areas along lower Yuba River; minimum facilities for health and safety at lake; about 14,350 acres for preservation and improvement of riparian vegetation and fish and wildlife habitat.		
1. National Economic Development	3-1/4%	6-3/8%		3-1/4%	6-3/8%		3-1/4%	6-3/8%	
a. Beneficial Impacts	*(Millions of Dollars)*			*(Millions of Dollars)*			*(Millions of Dollars)*		
(1) Value of increased output of goods and services									
(a) Hydroelectric power	97.3	91.7	*(2,6,10,14)*	5.0	4.9	*(3,6,10,14)*	88.1	77.5	*(3,6,10,14)*
(b) Water supply	10.1	10.8	*(2,6,10,14)*	7.7	8.3	*(3,6,10,14)*	10.1	10.8	*(3,6,10,14)*
(c) Flood control	5.6	5.0	*(2,6,10,14)*	5.6	5.0	*(3,6,10,14)*	5.6	5.0	*(3,6,10,14)*
(d) Recreation	1.4	1.1	*(2,5,10,14,15)*	1.4	1.1	*(3,5,10,14,15)*	0.9	0.7	*(3,5,10,14,15)*
(e) Fish and Wildlife enhancement	3.7	3.7	*(2,5,10,14,15)*	3.7	3.7	*(3,5,10,14,15)*	3.7	3.7	*(3,5,10,14,15)*
(2) Value of output from use of unemployed or underemployed resources in construction (ARA)	5.9	12.6	*(1,5,9,13)*	2.8	6.0	*(1,5,9,13)*	5.0	10.7	*(1,5,9,13)*
(3) Total NED Benefits (Annual)	124.2	124.9		26.2	29.0		113.4	108.4	
b. Adverse Impacts									
(1) Project costs (Annual)	53.5	95.3	*(3,6,9,14,15)*	23.8	44.5	*(1,3,6,9,14,15)*	51.0	87.3	*(1,3,6,9,14,15)*
(2) Total First Cost	1,120.0	1,120.0	*(1,6,9,14,15)*	564.0	564.0	*(1,6,9,14,15)*	1,088.0	1,055.0	*(1,6,9,14,15)*
c. Net NED Benefits	70.7	29.6		2.4	-15.5		61.6	19.6	
d. Benefit-to-Cost Ratio	2.3	1.3		1.1	0.7		2.2	1.2	

Index of Footnotes

Timing

1. *Impact is expected to occur prior to or during implementation of the plan.*
2. *Impact is expected within 15 years following plan implementation.*
3. *Impact is expected in a longer time frame (15 or more years following implementation).*

Uncertainty

4. *The uncertainty associated with the impact is 50% or more.*
5. *The uncertainty is between 10% and 50%.*
6. *The uncertainty is less than 10%.*

Exclusivity

7. *Overlapping entry; fully monetized in NED account.*
8. *Overlapping entry; not fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additional actions are carried out during implementation.*
11. *Impact will not occur because necessary additional actions are lacking.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area.*
14. *Within a larger area affected by the project.*
15. *Within the rest of the nation.*

Section 122

• *Items specifically required in Section 122 and ER 1105-2-240.*

SYSTEM OF ACCOUNTS (Cont'd)

ACCOUNTS	NED PLAN	EQ PLAN	SELECTED PLAN
2. Environmental Quality			
a. Environmental Quality Enhanced			
*(1) Enhance aesthetics	Enhance aesthetics of SPF flood plain by reducing flood damage. *(2,6,9,13)*	Enhance aesthetics of SPF flood plain by reducing flood damage. *(2,6,9,13)* Enhance aesthetics in vegetation and wildlife preservation areas. *(2,6,9,12)*	Same as EQ Plan
(2) Preserve riparian vegetation	Same as EQ Plan	1,620 acres along Dry Creek and lower Yuba River. *(2,6,9,12)*	Same as EQ Plan
(3) Improve wildlife habitat	Same as Selected Plan	Improve about 11,000 acres for wildlife; provide nesting sites for raptors. *(2,6,9,12)*	Same as EQ Plan, except improve about 14,350 acres for wildlife. *(2,6,9,12)*
(4) Enhance fishery	Hatchery, spawning channels, and gravel improvement and management would provide 70,000 salmon and 10,000 steelhead annually. Lake fishery would be created. *(2,6,7,10,14,15)*	Same as NED Plan, except smaller lake fishery. *(2,6,7,10,14,15)*	Same as NED Plan
(5) Improve Yuba River temperatures and flows	Regulate temperatures and guarantee minimum flows to 600/800/1,000 cfs except for 15 to 30% reduction through critical dry cycle; large reduction in floodflows. *(2,6,7,9,14)*	Regulate temperatures and increase minimum flows to 600/800/1,000 cfs except revert to 70/250/400 during dry years. Same floodflow reduction as NED Plan. *(2,6,8,9,14)*	Same as NED Plan
(6) Scarce fossil fuels conserved	Afterbay powerplant would produce 370 billion BTU's (110 GWh) per year; main powerplant would produce 5,900 billion BTU's (1,720 GWh) per year. *(2,6,8,9,15)*	Afterbay powerplant would generate 210 billion BTU's (60 GWh) per year; main powerplant would generate 1,300 billion BTU's (380 GWh) per year. *(2,6,8,9,15)*	Afterbay powerplant would generate 370 billion BTU's (110 GWh) per year; main powerplant would generate 5,700 billion BTU's (1,660 GWh) per year. *(2,6,8,9,15)*
(7) Protect archeological and historical sites on project lands above gross pool	185 identified sites. *(1,6,9,12)*	Approximately same as NED Plan	Same as NED Plan
b. Environmental Quality Degraded			
(1) Air quality degraded and noise level increased	Minor effects due to construction activity. *(1,6,9,12)* Minor effects by recreationists. *(2,6,9,12)*	Less than NED Plan	Same as NED Plan, except fewer recreationists.
(2) Aesthetics degraded	10 miles of free-flowing Yuba River and 10 miles of tributary streams converted to lake. *(2,6,9,12)*	10 miles of free-flowing Yuba River and 4 miles of tributary streams converted to lake. *(2,6,9,12)*	Same as NED Plan

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Timing

1. *Impact is expected to occur prior to or during implementation of the plan.*
2. *Impact is expected within 15 years following plan implementation.*
3. *Impact is expected in a longer time frame (15 or more years following implementation).*

Uncertainty

4. *The uncertainty associated with the impact is 50% or more.*
5. *The uncertainty is between 10% and 50%.*
6. *The uncertainty is less than 10%.*

Exclusivity

7. *Overlapping entry; fully monetized in NED account.*
8. *Overlapping entry; not fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additional actions are carried out during implementation.*
11. *Impact will not occur because necessary additional actions are lacking.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area.*
14. *Within a larger area affected by the project.*
15. *Within the rest of the nation.*

Section 122

* *Items specifically required in Section 122 and ER 1105-2-240.*

SYSTEM OF ACCOUNTS (Cont'd)

ACCOUNTS	NED PLAN	EQ PLAN	SELECTED PLAN
c. Environmental Quality Destroyed			
(1) Fossil fuels consumed	7,000 billion BTU's (2,000 GWh) for pumping annually. *(2,6,7,9,15)*	None	6,500 billion BTU's (1,900 GWh) for pumping annually. *(2,6,7,9,15)*
(2) Existing hydropower plants inundated	Loss of 940 billion BTU's (275 GWh) annually. *(1,6,7,9,15)*	Same as NED Plan	Same as NED Plan
(3) Whitewater boating lost	Class I and II, 8 miles. *(1,6,9,12)*	Same as NED Plan	Same as NED Plan
(4) Inundate natural stream fishery	20 miles. *(1,6,9,12)*	14 miles. *(1,6,9,12)*	Same as NED Plan
(5) Loss of existing spawning gravels	12 miles cut off by dams. *(1,6,9,12)*	Same as NED Plan	Same as NED Plan
*(6) Soils lost due to permanent inundation	2,500 acres of arable land inundated. *(2,6,8,9,12)*	100 acres of arable land inundated. *(2,6,8,9,12)*	Same as NED Plan
*(7) Vegetation lost due to project construction activities and permanent inundation	Riparian vegetation 280 acres. Upland forest 4,400 acres. *(1,6,9,12)* Grassland 1,500 acres. Misc. 1,220 acres.	Riparian vegetation 170 acres. Upland forest 3,170 acres. *(1,6,9,12)* Grassland 1,060 acres. Misc. 400 acres.	Same as NED Plan
(8) Wildlife displaced due to inundation	600 deer, 3,300 quail, 100 turkeys, and 15,500 songbirds. *(2,5,9,12)*	330 deer, 1,800 quail, 75 turkeys, and 8,500 nongame songbirds. *(2,5,9,12)*	Same as NED Plan
3. Social Well-Being			
a. Beneficial Impacts			
(1) Enhancement of public safety and community well-being	Risk of loss of life or serious injury to 90,000 people now living in SPF flood plain would be lessened. *(2,6,10,14)*	Same as NED Plan	Same as NED Plan
(2) Enhancement of public health	Periodic contamination of water supply during flooding would be reduced. *(2,6,10,14)*	Same as NED Plan	Same as NED Plan
*(3) Displacement of people lessened and improvement of community cohesion	Periodic evacuation and disruption during periods of flooding would be reduced for 33,000 homes in SPF flood plain. *(2,6,10,14)*	Same as NED Plan	Same as NED Plan
*(4) Improvement of educational and cultural opportunities	Timbuctoo Wells Fargo Building would be relocated and restored; Bridgeport Bridge would be relocated and preserved; $10.8 million salvage program would increase man's knowledge of his past. *(1,6,7,9,14,15)*	Same as NED Plan, except only $5.6 million for salvage.	Same as NED Plan

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Timing

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2. Impact is expected within 15 years following plan implementation.

3. Impact is expected in a longer time frame (15 or more years following implementation).

Uncertainty

4. The uncertainty associated with the impact is 50% or more.

5. The uncertainty is between 10% and 50%.

6. The uncertainty is less than 10%.

Exclusivity

7. Overlapping entry; fully monetized in NED account.

8. Overlapping entry; not fully monetized in NED account.

Actuality

9. Impact will occur with implementation.

10. Impact will occur only when specific additional actions are carried out during implementation.

11. Impact will not occur because necessary additional actions are lacking.

Location of Impacts

12. Within the immediate planning area.

13. Within the study area.

14. Within a larger area affected by the project.

15. Within the rest of the nation.

Section 122

** Items specifically required in Section 122 and ER 1105-2-240.*

SYSTEM OF ACCOUNTS (Cont'd)

ACCOUNTS	NED PLAN	EQ PLAN	SELECTED PLAN
(5) Enhance recreational opportunities	Annual increases in recreation use would be: Initial / Ultimate Lake - 350,000 / 1,000,000 L. Yuba R. - 130,000 / 400,000 Hatchery - 65,000 / 200,000 Hunting - 5,000 / 10,000 *(2,5,10,14,15)*	Same as NED Plan, except lake recreation increases would be 190,000 recreation-days initially, and 490,000 ultimately.	Same as NED Plan except: Initial / Ultimate Lake - 70,000 / 150,000 Lower Yuba - 95,000 / 300,000
*(6) Improvement of public facilities	Initial development of 4 recreation sites and trail system on lower Yuba River, plus 2 additional sites in future; 330 campsites, 285 picnic sites, 12 boat lanes and 1 beach at lake; replace Englebright facilities. *(2,6,7,10,13,15)*	Same as NED Plan, except 135 campsites, 65 picnic sites, 4 boat lanes. *(2,6,7,10,13,15)*	Same as NED Plan, except no trail system on lower Yuba River; minimum facilities for health and safety at lake (13 road ends). *(2,6,7,10,13,15)*
*(7) Protection to public facilities	Lessen flood damages to existing roads and other public facilities. *(2,6,9,14)*	Same as NED Plan	Same as NED Plan
b. Adverse Effects			
*(1) Disruption of community cohesion	Disruption of Smartville and other small communities due to relocations and influx of construction workers. *(1,5,10,12)*	Less than NED Plan	More than NED Plan
*(2) Displacement of people	500 people displaced. *(1,6,9,12)*	Less than NED Plan	Same as NED Plan
(3) Disruption of transportation	Temporary minor inconvenience during road relocations. *(1,6,10,12)*	Less than NED Plan	Same as NED Plan
*(4) Disruption of educational and cultural resources	Loss of 20% of land and research base at U.C. Field Station; inundation of 245 archeological/historical sites. *(2,6,7,9,12,15)*	Loss of 10% of land and research base at U.C. Field Station; inundation of 145 archaeological/historical sites. *(2,6,7,9,12,15)*	Same as NED Plan
	Possible crowding of schools due to influx of construction workers. *(1,5,9,13)*	Less than NED Plan	Slightly less than NED Plan
(5) Disruption of public facilities	Inundate Englebright Dam, Narrows Powerplants, and Englebright recreation facilities. *(2,6,7,9,12,15)*	Same as NED Plan	Same as NED Plan
(6) Relocation of cemeteries	100 graves relocated. *(1,6,7,9,12)*	Less than NED Plan	Same as NED Plan
(7) Changes in way of life	Possible changes in life-style of local residents from rural to more commercial nature, due to influx of construction workers *(1)*, recreationists, and vacation home development. *(2,5,10,12)*	Slightly less than NED Plan	Less than NED Plan

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Uncertainty

4. *The uncertainty associated with the impact is 50% or more.*
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Exclusivity

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8. *Overlapping entry; not fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additional actions are carried out during implementation.*
11. *Impact will not occur because necessary additional actions are lacking.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area.*
14. *Within a larger area affected by the project.*
15. *Within the rest of the nation.*

Section 122

* *Items specifically required in Section 122 and ER 1105-2-240.*

SYSTEM OF ACCOUNTS (Cont'd)

ACCOUNTS	NED PLAN	EQ PLAN	SELECTED PLAN
4. Regional Development			
a. Beneficial Impacts			
*(1) Value of increased income	Increased income to local area due to recreation tourism. *(2,5,10,13)*	Less than NED Plan	Much less than NED Plan
*(2) Quantity of increased employment	Slightly more than Selected Plan	Less than Selected Plan	Maximum of 1,935 jobs during construction for local residents. *(1,5,7,9,13)* 50 jobs to maintain project after construction. *(2,6,7,9,13)* Maximum of 1,585 jobs during construction for non-locals. *(2,6,8,9,15)*
*(3) Decreased business and industrial losses	Average annual business losses due to flooding would be reduced. *(2,6,8,9,14)*	Same as NED Plan	Same as NED Plan
*(4) Desirable community growth	Future development could occur in SPF flood plain with less threat of flooding. *(2,6,8,9,14)*	Same as NED Plan	Same as NED Plan
(5) Increased property values and tax revenue	Property values in SPF flood plain would be enhanced due to increased flood protection. *(2,6,8,9,14)* Property values near reservoir would be enhanced. *(1,5,9,12)* Increased property values would result in additional tax revenues. *(1,2,5,9,13)*	Same as NED Plan, except fewer properties would appreciate near reservoir, and tax revenue increases would be less.	Same as NED Plan
(6) Annual irrigation yield	150,000 acre-feet	115,000 acre-feet	150,000 acre-feet
b. Adverse Impacts			
*(1) Value of income lost	OM&R of lake and lower Yuba River recreation sites by local sponsor = $171,500 annually. *(2,6,7,14)*	Slightly less than NED Plan	Annual OM&R of lower Yuba River recreation sites by Yuba Co. = $25,000 initially; $75,000 ultimately. *(2,6,7,14)*
	Project would remove $2.2 million assessed valuation from Yuba Co. tax rolls (2.2%), resulting in minor temporary loss of tax revenues. *(1,6,9,12)*	Less than NED Plan	Same as NED Plan
	Project would remove 12,100 acres of land from BVID special assessment district, resulting in temporary loss of income to BVID. *(1,5,8,10,12)*	1,000 acres of lands removed from BVID.	Same as NED Plan
(2) Displacement of farms	0 acres of Class I farmland disrupted. 0 acres of Class II farmland disrupted. 150 acres of Class III farmland disrupted. 2,350 acres of Class IV farmland disrupted. 40% is presently irrigated. *(1,6,7,9,12)*	0 acres of Class I farmland disrupted. 0 acres of Class II farmland disrupted. 0 acres of Class III farmland disrupted. 100 acres of Class IV farmland disrupted. 50% is presently irrigated. *(1,6,7,9,12)*	Same as NED Plan

All other regional income and employment - not evaluated.

Index of Footnotes

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Uncertainty

4. *The uncertainty associated with the impact is 50% or more.*
5. *The uncertainty is between 10% and 50%.*
6. *The uncertainty is less than 10%.*

Exclusivity

7. *Overlapping entry; fully monetized in NED account.*
8. *Overlapping entry; not fully monetized in NED account.*

Actuality

9. *Impact will occur with implementation.*
10. *Impact will occur only when specific additional actions are carried out during implementation.*
11. *Impact will not occur because necessary additional actions are lacking.*

Location of Impacts

12. *Within the immediate planning area.*
13. *Within the study area.*
14. *Within a larger area affected by the project.*
15. *Within the rest of the nation.*

Section 122

* *Items specifically required in Section 122 and ER 1105-2-240.*

SECTION XI - COST ALLOCATION AND REPAYMENT

70. General. -

The separable cost-remaining benefits (SC-RB) method was used to prepare a preliminary allocation of costs to the power, water supply, flood control, recreation, and anadromous fish enhancement purposes, with the objective of distributing the investment and annual costs of the multiple-purpose project to the various purposes served. This method was recommended in "Proposed Practices for Economic Analysis of River Basin Projects," May 1958, and is in accordance with a 12 March 1954 agreement among the Departments of Interior and Army and the Federal Power Commission. The SC-RB method of cost allocation is a method for obtaining an equitable distribution of the costs of a multiple-purpose project among the purposes served. Briefly, it provides for: (1) assigning to each purpose its separable costs, i.e., the added costs of including the purpose in the project; and (2) assigning to each purpose a share of the residual or remaining joint costs in proportion to the remaining benefits; i.e., the benefits (as limited by alternative costs) less the separable costs. Thus, the method provides for an equitable sharing among the purposes in the savings resulting from multiple-purpose development.

71. Costs and charges. -

a. Nonallocable costs. - There are certain project costs included in the appropriations required for construction which by law or administrative

regulation are excluded from the plan economic analysis and are not to be allocated to the purposes of the water resources plan. In accordance with Public Law 87-874, Flood Control Act of 1960 (section 207(c)), and Water Resources Development Act of 1974 (section 13), the Federal Government is obligated to replace relocated roads to meet prevailing design standards which are generally higher than those for replacement in kind. Costs to replace roads over and above replacement in kind but not exceeding current design standards are considered nonallocable betterments. The preliminary estimate of this nonallocable betterment is one-half the cost of relocating Highway 20 and the county roads. The betterment cost is estimated as $11,900,000, which includes the cost for lands, construction, engineering and design, and supervision and administration (E&D and S&A).

Costs incurred for cultural resource preservation are also non-allocable Federal project costs and were excluded from the allocation process. In accordance with Public Law 86-523 of June 1960, as amended in 1974 by Public Law 93-291, the Federal Government authorizes project funds for survey, recovery, analysis, and reporting of important scientific, historical, archeological, and paleontological data which may be irreparably lost or destroyed as a result of civil works construction on Federally-owned lands. Construction of dams and subsequent flooding of the reservoir area would inundate numerous archeological and historical sites. These sites, if subjected to the weathering processes of inundation, would be destroyed. Consequently, measures for salvage and preservation of many of these sites are planned. Estimated cost to provide cultural resource

preservation is estimated at $10,770,000, including E&D and S&A, based on an estimated one percent of the total project cost.

In addition, relocation costs incurred to provide assistance in relocating people out of the project area, in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act, PL 91-646, are nonallocable costs and are estimated at $946,000.

The nonallocable costs are summarized below.

Highway Betterments	$11,900,000
Cultural Resources Preservation	10,770,000
Relocations	946,000
	$23,616,000

b. Construction costs. - Construction costs for the Marysville Lake project include both initial development (Stage I) and present worth costs of future development (Stage II development and future recreation facilities). The total estimated cost of Stage I development is $962,500,000 which includes $1,500,000 for Federally-owned lands transferred without cost. The estimated present worth cost (at 3-1/4 percent interest) of Stage II development is $127,100,000, and for future recreation facilities it is $110,000. The total estimated present worth cost of project development, including cost of Federally-owned lands transferred to the project without cost, is $1,089,710,000. However, allocable project costs must exclude $23,616,000 for highway betterments, cultural resources preservation, and relocation costs, and the total estimated allocable cost is $1,066,094,000. The selective withdrawal facilities are joint use costs.

Specific costs for power include Stage I costs of $387,384,000 for the power intake works, powerhouse, turbine generators, switchyard, afterbay, afterbay dam, and power units in the afterbay dam. Stage II specific power cost at present worth would be $127,100,000 for installation of an additional 900 MW of nameplate capacity in the powerhouse and for raising the afterbay dam. The total estimated present worth specific power cost is $514,484,000.

Specific recreation costs are estimated at $1,743,000. This includes $470,000 for lands and initial development of recreation access sites along the lower Yuba River, $1,178,000 for acquisition of lands at the lake to preserve the opportunity for future recreation development pursuant to PL 89-72 (there presently is no non-Federal sponsor for development of recreation on these lands), and $110,000 (present worth) for future development and expansion of facilities along the lower Yuba River. Costs for development of minimum facilities for health and safety at the lake are joint use costs.

Specific costs for anadromous fish enhancement are estimated as $16,700,000 for the fish hatchery and spawning gravels.

The allocable costs (including present worth of future construction) are itemized in Table 1 at the end of this appendix and summarized as follows.

Specific Power (Stage I & Stage II)	$ 514,484,000
Specific Recreation (Initial & Future)	1,743,000
Specific Anadromous Fish Enhancement	16,700,000
Joint Use Facilities	533,167,000
Total	$1,066,094,000

c. Interest during construction. - Interest during construction was computed on contracts exceeding two years duration. Calculations for allocable present worth of interest during construction are shown in Table 2 at the end of this appendix and are summarized as follows.

Specific Power	$42,406,000 1/
Joint Use Facilities	49,408,000
Total	$91,814,000

1/ Includes present worth of Stage II costs.

d. Operation and maintenance costs. - Estimated allocable annual operation and maintenance costs over the 100-year economic life of the Marysville Lake project is an average equivalent annual cost (discounted) of $10,144,600. The specific power costs include pumping costs for initial and future facilities. The annual operation and maintenance cost for the lower Yuba River recreation is $25,000 for the initial facilities and an equivalent annual cost of $13,200 for the future facilities (based on an average annual O&M cost of $26,000 for these future facilities). The average annual equivalent operation and maintenance costs for specific and joint-use facilities are shown in Table 3 at the end of this appendix and are summarized as follows.

Specific Power	$ 7,643,000
Specific Recreation	38,200
Specific Anadromous Fish Enhancement	676,000
Joint Use Facilities	1,787,400
Total	$10,144,600

e. Major replacements. - The allocable average annual equivalent cost for major replacements are shown in Table 3 and are summarized as follows.

Specific Power	$1,422,900
Specific Recreation	0
Specific Anadromous Fish Enhancement	33,000
Joint Use Facilities	35,400
Total	$1,491,300

f. Average annual equivalent costs. - Table 4 at the end of this appendix shows the present worth of allocable investment costs, allocable average annual equivalent costs, and benefits for the selected plan, for alternative multiple-purpose projects with one function removed, and for alternative single-purpose projects.

72. Project benefits. -

Detailed discussion of project benefits is given in Section IX. The average annual equivalent benefits for the selected plan are shown in Tables 4 and 5 at the end of this appendix.

The power benefits are based on the Federal Power Commission (FPC) power values at 1 January 1976 price levels, the latest available. The power benefits reflect a reduction in equivalent annual benefits due to initial filling of the reservoir, and are reduced by the cost of transmission facilities.

The $16,566,000 benefits for the flood control purpose used in the cost allocation (shown on Table 5) are based on a system benefit analysis which provides for an equitable sharing of flood control benefits between the three-dam complex of Oroville Dam (State of California), New Bullard's Bar Dam (Yuba County Water Agency) and Marysville Lake along the Feather and Yuba Rivers. A discussion of system benefits is presented in paragraph 61j. (The project economic justification is based on a last added increment analysis with flood control benefits of $5,564,000, shown on Table 4.)

Area redevelopment benefits are not included in the cost allocation analysis.

73. <u>Alternative projects</u>. -

Cost estimates were made for the least costly single-purpose alternative project that would provide the same benefits and accomplishments in the absence of the multiple-purpose selected plan. Cost estimates were also developed for multiple-purpose projects with one function removed for comparison to the selected plan to determine the separable cost of each

purpose, i.e., all costs incurred for inclusion of that purpose. For cost allocation, the alternative projects were evaluated on the same basis as the selected plan, i.e., some costs were nonallocable, the cost of Federal lands transferred to the project without cost were included, etc. Location, size, costs and benefits for these alternatives are shown in Table 4. A brief description of the alternative projects are given in the following paragraphs.

a. Alternative single-purpose projects. -

- Power. - In the absence of the selected plan the least costly alternative power project that would provide the same power accomplishments as shown on Table 5 would be a combustion-turbine peaking powerplant. It would be a Federally-financed plant with the costs of providing the same power accomplishments evaluated at 3-1/4 percent interest rate, using data provided by the FPC. The average annual equivalent costs, as shown on Table 4 would be $65,347,000.

- Flood control. - The single-purpose alternative flood control project would be a dam located on the Yuba River at the authorized Browns Valley site. Alternative methods of providing flood control were also evaluated, such as a levee alteration plan, flood bypass plan, South Yuba diversion plan, etc., but they did not provide the same level of flood control accomplishments as a reservoir project. A single-purpose flood control project at the Parks Bar site was also evaluated but it would cost

$10,710,000 more than a project at the Browns Valley site. An alternative single-purpose flood control project located at the authorized Browns Valley site would have a gross pool storage of 311,000 acre-feet at elevation 260 feet mean sea level (msl) to provide the required storage to control the SPF on the main stem Yuba River. The allocable investment and annual costs are shown in Table 4, and the total and allocable investment and annual costs are compared below.

	Total Costs	Allocable Costs
Investment	$225,530,000	$208,199,000
Annual	$ 9,370,000	$ 8,769,000

- Water supply. - The alternative single-purpose water supply project would be a dam and reservoir at the Parks Bar site. It would have a gross pool storage of 574,000 acre-feet at elevation 502 feet msl to provide 150,000 acre-feet of average annual yield. The allocable investment and annual costs are shown in Table 4, and the total and allocable investment and annual costs are compared below.

	Total Costs	Allocable Costs
Investment	$366,680,000	$354,602,000
Annual	$ 13,300,000	$ 12,704,000

- Recreation. - The alternative single-purpose recreation project would be a dam and reservoir located at the Browns Valley site to provide the same potential recreation usage as the potential provided by the optimum recreation plan of the selected plan. This project would have a gross pool

storage of 630,000 acre-feet at elevation 305 feet msl. The allocable investment and annual costs are shown in Table 4, and the total and allocable investment and annual costs are compared below.

	Total Costs	Allocable Costs
Investment	$328,280,000	$309,802,000
Annual	$ 13,245,000	$ 12,580,000

- Anadromous fish enhancement. - The single-purpose alternative anadromous fish enhancement project would be a fish hatchery located at Daguerre Point Dam able to accommodate 70,000 returning salmon and 10,000 returning steelhead. The allocable investment and annual costs are shown in Table 4, and the total and allocable investment and annual costs are compared below.

	Total Costs	Allocable Costs
Investment	$18,650,000	$18,650,000
Annual	$ 1,663,000	$ 1,663,000

b. Multiple-purpose projects with one function removed. - The alternative multiple-purpose projects with one function removed are all located on the Yuba River at the Parks Bar site. The multiple-purpose project without water supply is identified with the selected plan. Table 4 shows the costs, charges, and benefits for these alternative projects. Table 6 at the end of this section shows the separable and residual costs.

74. <u>Cost allocation analysis</u>. -

The cost allocation by SC-RB methods is shown in Table 7 at the end of this appendix. A summary of the allocation is shown in Table 8.

The costs for minimum facilities for health and safety at the lake have been assigned to joint use costs; however, the benefits derived from these facilities have been assigned to the recreation function. The costs associated with providing visitor facilities at the fish hatchery would be part of the Federal program for anadromous fish enhancement and have been assigned to anadromous fish enhancement; however, fish hatchery visitor day-use benefits have been assigned to recreation.

Allocation of joint use construction costs, investment costs, and OM&R costs, are as follows and are shown in Table 8.

	Specific Cost	Allocated Joint Use Cost		Total	
	$1,000	$1,000	%	$1,000	%
Construction Costs					
Power	514,484	383,460	71.9	897,944	84.3
Flood Control	0	74,391	14.0	74,391	7.0
Water Supply	0	66,444	12.4	66,444	6.2
Recreation	1,743	6,141	1.1	7,884	0.8
Fish and Wildlife Enhancement	16,700	2,731	0.6	19,431	1.7
Total	532,927	533,167	100.0	1,066,094	100.0
Investment Costs					
Power	556,890	418,995	71.9	975,885	84.3
Flood Control	0	81,285	14.0	81,285	7.0
Water Supply	0	72,601	12.5	72,601	6.3
Recreation	1,743	6,710	1.1	8,453	0.7
Fish and Wildlife Enhancement	16,700	2,984	0.5	19,684	1.7
Total	575,333	582,575	100.0	1,157,908	100.0
Annual OM&R					
Power	9,067	1,471	80.7	10,538	90.5
Flood Control	0	158	8.7	158	1.4
Water Supply	0	184	10.1	184	1.6
Recreation	38	7	0.4	45	0.4
Fish and Wildlife Enhancement	709	2	0.1	711	6.1
Total	9,814	1,822	100.0	11,636	100.0

75. Repayment. -

a. Power. - On the basis of the allocation given above, the allocation to power includes $383,460,000 or 71.9 percent of the total joint use construction costs and $514,484,000 of construction costs for specific facilities. The allocation of annual OM&R costs to power consists of $9,067,000 specific costs and $1,471,000 or 80.7 percent of the annual joint use operation, maintenance and replacement costs. Upon completion of construction, Marysville Lake power will be financially integrated with the Central Valley Project (CVP). The costs of Marysville Lake allocated to power will become a part of CVP costs and will be repaid in accordance with Reclamation Law by the users of power and water. The Bureau of Reclamation is responsible for execution of the repayment contracts.

b. Irrigation water supply. - From the allocation above, the allocated joint use construction cost for water supply would be $66,444,000. There are no specific costs. The allocation of annual joint use OM&R for water supply would be $184,000. Like the power purpose, the irrigation water supply would be financially integrated with the CVP.

c. Recreation. - In accordance with provisions of PL 89-72 and the authorizing document, local interests are required to bear one-half the separable cost allocated to recreation and all the annual operation, maintenance and replacement costs associated with the recreation function. The separable investment recreation costs, as shown in Table 6, are estimated

as $3,545,000. However, this separable cost for recreation includes $1,178,000 for lands acquired for future recreation development. The costs of these lands should not be cost-shared for at this time and should be charged to a nonreimbursable recreation account. The separable costs for development of the lower Yuba River facilities are estimated to be $565,000, of which $455,000 is for land and facilities for initial development and $110,000 is the present worth of projected future facilities. Therefore, the one-half non-Federal share would be $282,000, including $227,000 for initial facilities and $55,000 present worth for future development. The annual operation and maintenance costs for the initial facilities are estimated to be $25,000. The average annual operation and maintenance costs for the future recreation facilities, based on projected development is estimated to be $26,000, with an average annual equivalent cost of $13,200.

d. Flood control. - This is a nonreimbursable function.

e. Anadromous fish enhancement. - This is a nonreimbursable function.

TABLE 1
COST ALLOCATION
SUMMARY OF CONSTRUCTION EXPENDITURES 1/
(x $1,000)

	Multiple-Purpose Project				
	Specific Cost			Joint Use Cost	Total Costs
	Power	Recreation	Anadromous Fish Enhancement		
Lands and Damages		1,250		38,432 2/	39,682
Relocations				13,049	13,049
Reservoirs				8,060	8,060
Dams				465,745	465,745
Power initial	131,190				131,190
Power future 3/	19,189				19,189
Fish and Wildlife Facilities				1,800	1,800
Anadromous fish enhancement			16,700		16,700
Powerplant					
Power initial	256,087				256,087
Power future 3/	107,332				107,332
Roads				1,880	1,880
Power future 3/	199				199
Recreation Facilities				817 4/	817
Recreation initial		383			383
Recreation future 3/		110			110
Buildings, Grounds & Utilities				2,259	2,259
Power initial	105				105
Power future 3/	382				382
Permanent Operating Equipment				1,125	1,125
Total Allocable Project Costs 1/	514,484	1,743	16,700	533,167	1,066,094

1/ Exclusive of $946,000 nonallocable Relocations Assistance costs, $11,900,000 nonallocable Highway Betterment costs and $10,770,000 nonallocable Cultural Resources Peservation costs.
2/ Includes $1,500,000 estimated market value of Federally-owned lands transferred to project.
3/ Equivalent first cost.
4/ Minimum facilities at lake as joint use costs.

TABLE 2
COST ALLOCATION
INTEREST DURING CONSTRUCTION

	Specific Power Costs	Joint Costs
Stage I		
Contracts		
(1) Yuba River Dam and Powerplant		
7 yrs x 3-1/4% x 1/2 x $257,545,000 x 1.125 1/	$32,958,000	
7 yrs x 3-1/4% x 1/2 x 314,455,000 x 1.125		$40,240,000
Total $572,000,000		
(2) Dry Creek Dam		
5 yrs x 3-1/4% x 1/2 x $100,300,000 x 1.125		9,168,000
(3) Afterbay Dam and Powerplant		
3 yrs x 3-1/4% x 1/2 x $65,700,000 x 1.125	3,603,000	
Subtotal	$36,561,000	$49,408,000
Total - Stage I	$85,969,000	
Stage II		
Contracts		
(1) Yuba River Dam Powerplant		
3 yrs x 3-1/4% x 1/2 x $127,900,000 x 1.145	$ 7,139,000	
(2) Afterbay Dam and Powerplant and Power Intake Works		
2 yrs x 3-1/4% x 1/2 x $24,400,000 x 1.145	908,000	
Subtotal	$ 8,047,000	
Present Worth Stage II		
$8,047,000 x 0.7263	$ 5,845,000	
Total - Stage II, Present Worth	$ 5,845,000	
Total - Specific Power, Present Worth	$42,406,000	
Total - Stage I plus Stage II, Present Worth	$91,814,000	

1/ X years x 3-1/4% x 1/2 x (Cost + E&D + S&A).

TABLE 3
COST ALLOCATION
SUMMARY OF ANNUAL OPERATION AND MAINTENANCE AND REPLACEMENT COSTS 1/

	Multiple-Purpose Project				
	Specific Costs			Joint Use Costs	Total Costs
	Power	Recreation	Anadromous Fish Enhancement		
Operation and Maintenance					
Reservoir				92,200	92,200
Dams	439,400 2/			1,282,500 3/	1,721,900
Fish and Wildlife Facilities					
Hatchery			676,000		676,000
Wildlife Areas				72,000	72,000
Powerplant	1,800,600 2/				1,800,600
Roads	3,900 2/			37,700	41,600
Recreation					
Reservoir				105,000	105,000
Lower Yuba River		38,200 2/			38,200
Buildings, Grounds and Utilities	20,100 2/			114,000	134,100
Permanent Operating Equipment				84,000	84,000
Pumping Cost	5,379,000 2/				5,379,000
Subtotal Operation and Maintenance	7,643,000	38,200	676,000	1,787,400	10,144,600
Major Replacements	1,422,900 2/	0	33,000	35,400	1,491,300
Total	$9,065,900	$38,200	$709,000	$1,822,800	$11,635,900

1/ Exclusive of nonallocable costs for Cultural Resources Preservation: O&M $13,500; Replacement $900.
2/ Includes equivalent annual cost for operation and maintenance (or replacement) for future facilities.
3/ Includes $16,000 payment to counties for tax loss.

TABLE 4
COST ALLOCATION
SUMMARY OF COSTS, CHARGES AND BENEFITS[1]

(Thousands of Dollars)

	Multiple-Purpose Project Total[2]	Alternative Projects									
		Multiple-Purpose with One Function Removed					Single-Purpose Project				
		Power	Flood Control	Water Supply	Recreation	Anadromous Fish Enhancement	Power	Flood Control	Water Supply	Recreation	Anadromous Fish Enhancement
Location	Yuba River, Parks Bar Site							Yuba River Browns Valley Site	Yuba River Parks Bar Site	Yuba River Browns Valley Site	Yuba River Daguerre Point Damsite
Reservoir Capacity, Acre-Feet	916,000	629,000	838,000	916,000	916,000	916,000		311,000	574,000	630,000	--
Reservoir Elevation, Feet, MSL	560	512	548	560	560	560		260	502	305	--
Construction Costs	1,066,094	368,961	1,044,230	1,066,094	1,062,549	1,049,207		195,929	330,382	287,222	18,650
Interest During Construction											
Specific Power	42,406			42,406	42,406	42,406					
Joint Use	49,408	25,900		49,408	49,408	49,408					
Total	91,814	25,900	89,755	91,814	91,814	91,814		12,270	24,220	22,580	0
Federal Investment	1,157,908	394,861	1,133,985	1,157,908	1,154,363	1,141,021		208,199	354,602	309,802	18,650
Average Annual Equivalent Charges											
Interest and Amortization	39,230	13,378	38,420	39,230	39,110	38,658		7,053	12,014	10,497	632
Adjustment for Loss of Productivity of Lands	238	211	238	238	206	238		140	170	269	0
Operation and Maintenance	10,145	1,576	10,135	10,145	10,112	9,474		1,526	497	1,764	999
Major Replacements	1,491	60	1,488	1,491	1,491	1,458		50	23	50	32
Total	51,104	15,225	50,281	51,104	50,919	49,828	65,347[3]	8,769	12,704	12,580	1,663
Average Annual Equivalent Benefits											
Power	88,119	--	88,119	88,119	88,119	88,119	65,347				
Flood Control[4]	5,564	5,564	--	5,564	5,564	5,564		5,564			
Water Supply	10,062	10,062	10,062	--	10,062	10,062			10,062		
Recreation	868	868	868	868	--	868				868	
Anadromous Fish Enhancement	3,718	3,718	3,718	3,718	3,718	--					3,718
Total	108,331	20,212	102,767	98,269	107,463	104,613					
Benefit to Cost Ratio	2.12 to 1	1.33 to 1	2.04 to 1	1.92 to 1	2.11 to 1	2.10 to 1	1 to 1	0.63 to 1	0.79 to 1	0.07 to 1	2.24 to 1

1/ Costs, charges, and benefits are present worth costs and average annual equivalent charges or benefits.

2/ (a) Exclusive of nonallocable relocations assistance costs: construction, $946,000; investment, $946,000; interest and amortization, $32,000.
(b) Exclusive of nonallocable highway betterment costs: construction, $11,900,000; investment, $11,900,000; interest and amortization, $404,200.
(c) Exclusive of nonallocable Cultural Resources Preservation costs: construction, $10,770,000; investment, $10,770,000; interest and amortization, $364,900; operation/maintenance, $13,500; replacement, $900.

3/ Federally-financed powerplant.

4/ The project justification is based on Last Added Increment benefits, $5,564,000.

TABLE 5
COST ALLOCATION
ANNUAL BENEFITS, MULTIPLE-PURPOSE PROJECT
October 1976 Price Levels

1. Power 1/		
Yuba River Dam Powerplant		
Stage I (1,350,000 kW initial installation)		
Capacity: 1,259,000 2/ kW at $26.89/kW		
Energy : 1,124,000,000 2/ kWh at 28.97 mills/kWh		
Average Annual Equivalent Benefit, Capacity plus Energy	$63,390,000	
Stage II (Additional 900,000 kW installed in year 2000)		
Capacity: 773,000 kW at $26.89/kW		
Energy : 595,000,000 kWh at 28.97 mills/kWh		
Average Annual Equivalent Benefit, Capacity plus Energy	27,166,000	
Afterbay Dam Powerplant (15,000 kW nameplate capacity)		
Capacity: 9,500 kW		
Energy : 77,500,000 kW with 1,350 MW 80,600,000 kW with 2,250 MW		
Average Annual Equivalent Benefit, Capacity plus Energy	1,759,000	
Subtotal Power Benefits	$92,315,000	
Less Cost of Transmission Facilities	-4,196,000	
Net Benefit		$ 88,119,000
2. Flood Control		16,566,000 3/
3. Water Supply		
150,000 AF at $67.08/AF		10,062,000
4. Recreation		868,000
5. Anadromous Fish Enhancement		3,718,000
Total		$119,333,000

1/ Power benefits at 1 Jan 76 price levels.
2/ After initial filling of reservoir.
3/ Based on System Analysis. Last Added Increment analysis used in project justification analysis is $5,564,000.

TABLE 6
COST ALLOCATION
DETERMINATION OF SEPARABLE AND RESIDUAL COSTS
(x $1,000)

			Annual Charges				
	Construction Expenditures	Investment	Operation and Maintenance	Major Replacements	Interest and Amortization	Loss of Land Productivity	Total
Multiple-Purpose Project							
Selected Plan	1,066,094	1,157,908	10,145	1,491	39,230	238	51,104
Without Power	368,961	394,861	1,576	60	13,378	211	15,225
Without Flood Control	1,044,230	1,133,985	10,135	1,488	38,420	238	50,281
Without Water Supply	1,066,094	1,157,908	10,145	1,491	39,230	238	51,104
Without Recreation	1,062,549	1,154,363	10,112	1,491	39,110	206	50,919
Without Anadromous Fish Enhancement	1,049,207	1,141,021	9,474	1,458	38,658	238	49,828
Separable Cost							
Power	697,133	763,047	8,569	1,431	25,852	27	35,879
Flood Control	21,864	23,923	10	3	810	0	823
Water Supply	0	0	0	0	0	0	0
Recreation	3,545	3,545	33	0	120	32	185
Anadromous Fish Enhancement	16,887	16,887	671	33	572	0	1,276
Total Separable Cost	739,429	807,402	9,283	1,467	27,354	59	38,163
Residual Cost	326,665	350,506	862	24	11,876	179	12,941

TABLE 7
COST ALLOCATION
ALLOCATION BY SEPARABLE COSTS - REMAINING BENEFITS METHOD 1/
($1,000)
(October 1976 prices and 3-1/4 percent interest rate) 2/

	Power	Flood Control	Water Supply	Recreation	Anadromoua Fish Enhancement	Total
Allocation of Annual Costa						
Average annual benefits	88,119 3/	16,566 4/	10,062	868	3,718	119,333
Alternative costs	65,347	8,769	12,704	12,580	1,663	
Benefits limited by alternative cost	65,347	8,769	10,062	868	1,663	
Separable costa	35,879	823	0	185	1,276	38,163
Remaining benefits	29,468	7,946	10,062	683	387	48,546
Percent remaining benefita	60.70	16.37	20.72	1.41	0.80	100
Allocated residual costs	7,855	2,118	2,682	182	104	12,941
Total allocation economic costs	43,734	2,941	2,682	367	1,380	51,104
Adjustment for net loss of land productivity	135	29	39	34	1	238
Total allocation project coats	43,599	2,912	2,643	333	1,379	50,866
Allocation of Operation and Maintenance						
Separable costs	8,659	10	0	33	671	9,283
Allocated residual cost	523	141	179	12	7	862
Total O&M allocation	9,092	151	179	45	678	10,145
Specific O&M costs	7,644	0	0	38	676	8,358
Allocated joint use costs	1,448	151	179	7	2	1,787
Percent joint use	81.03	8.45	10.02	0.39	0.11	100
Allocation of Major Replacements						
Separable costa	1,431	3	0	0	33	1,467
Allocated reaidual cost	15	4	5	0	0	24
Total replacement allocation	1,446	7	5	0	33	1,491
Specific replacement coats	1,423	0	0	0	33	1,456
Allocated joint use costs	23	7	5	0	0	35
Percent joint use	66	20	14	0	0	100
Allocation of Inveatment						
Annual investment costs (I&A)	33,061	2,754	2,459	288	668	39,230
Percent annual investment	84.28	7.02	6.27	0.73	1.70	100
Allocated investment	975,885	81,285	72,601	8,453	19,684	1,157,908
Allocation of Conatruction Costs						
Specific investment costs	556,890	0	0	1,743	16,700	575,333
Joint use investment	418,995	81,285	72,601	6,710	2,984	582,575
Joint use interest during construction	35,535	6,894	6,157	569	253	49,408
Joint use conatruction	383,460	74,391	66,444	6,141	2,731	533,167
Percent conatruction joint use	71.92	13.96	12.46	1.15	0.51	100
Specific construction cost	514,484	0	0	1,743	16,700	532,927
Total construction cost	897,944	74,391	66,444	7,884	19,431	1,066,094

1/ Exclusive of nonallocable Relocationa Assistance, Highway Betterment and Cultural Resources Preservation coats as noted in Table 4.
2/ Costs shown include present worth costs and average annual equivalent costa of future facilities.
3/ January 1976 price levela, latest available.
4/ Based on System Analysis.

TABLE 8
COST ALLOCATION
SUMMARY
(x $1,000)

	Power	Flood Control	Water Supply	Recreation	Anadromous Fish Enhancement	Total
Construction Expenditures 1/						
Total Allocation	897,944	74,391	66,444	7,884	19,431	1,066,094
Specific Expenditures	514,484	0	0	1,743	16,700	532,927
Allocated Joint Expenditures	383,460	74,391	66,444	6,141	2,731	533,167
Percent of Joint Expenditures	71.92	13.96	12.46	1.15	0.51	100.00
Operation and Ordinary Maintenance						
Total Allocation	9,092	151	179	45	678	10,145
Specific Costs	7,644	0	0	38	676	8,358
Allocated Joint Costs	1,448	151	179	7	2	1,787
Percent of Cost of Joint Use Facilities	81.03	8.45	10.02	0.39	0.11	100.00

1/ Exclusive of $946,000 Relocations Assistance costs, $11,900,000 of Highway Betterment costs and $10,770,000 Cultural Resources Preservation costs. Includes $1,500,000 of Government owned lands.

APPENDIX K
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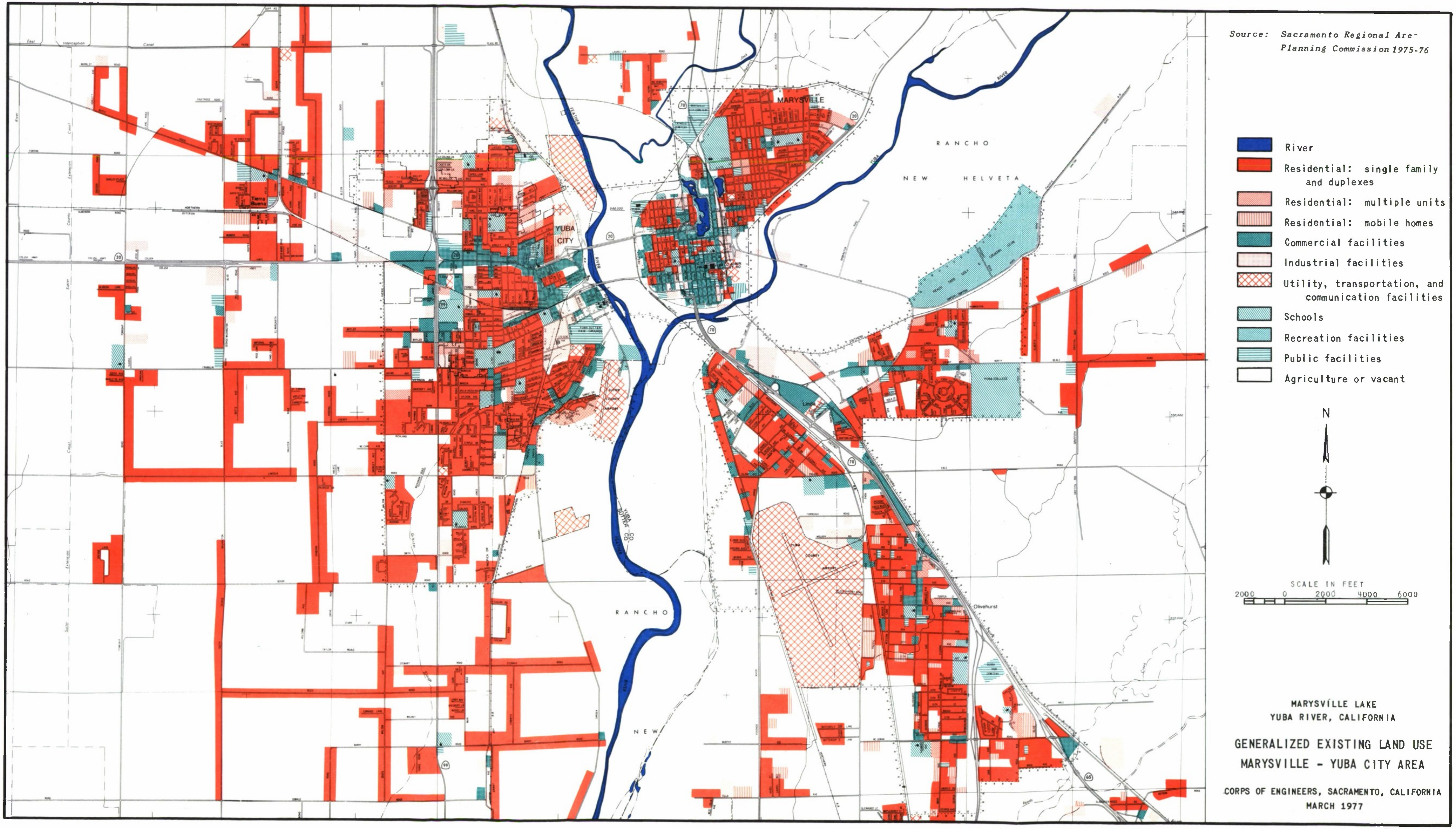
(5) State of California, Office of the Controller, Annual Report of Assessed Valuation and Tax Rates as of September 1975 of the Counties of California for the Fiscal Year 1975-76, 1975.

(6) Sutter-Yuba County Health Department, Tom Goff, Senior Sanitary Inspector, Environmental Health Division, 1974.

(7) Yuba County Grand Jury Final Report, 1972.

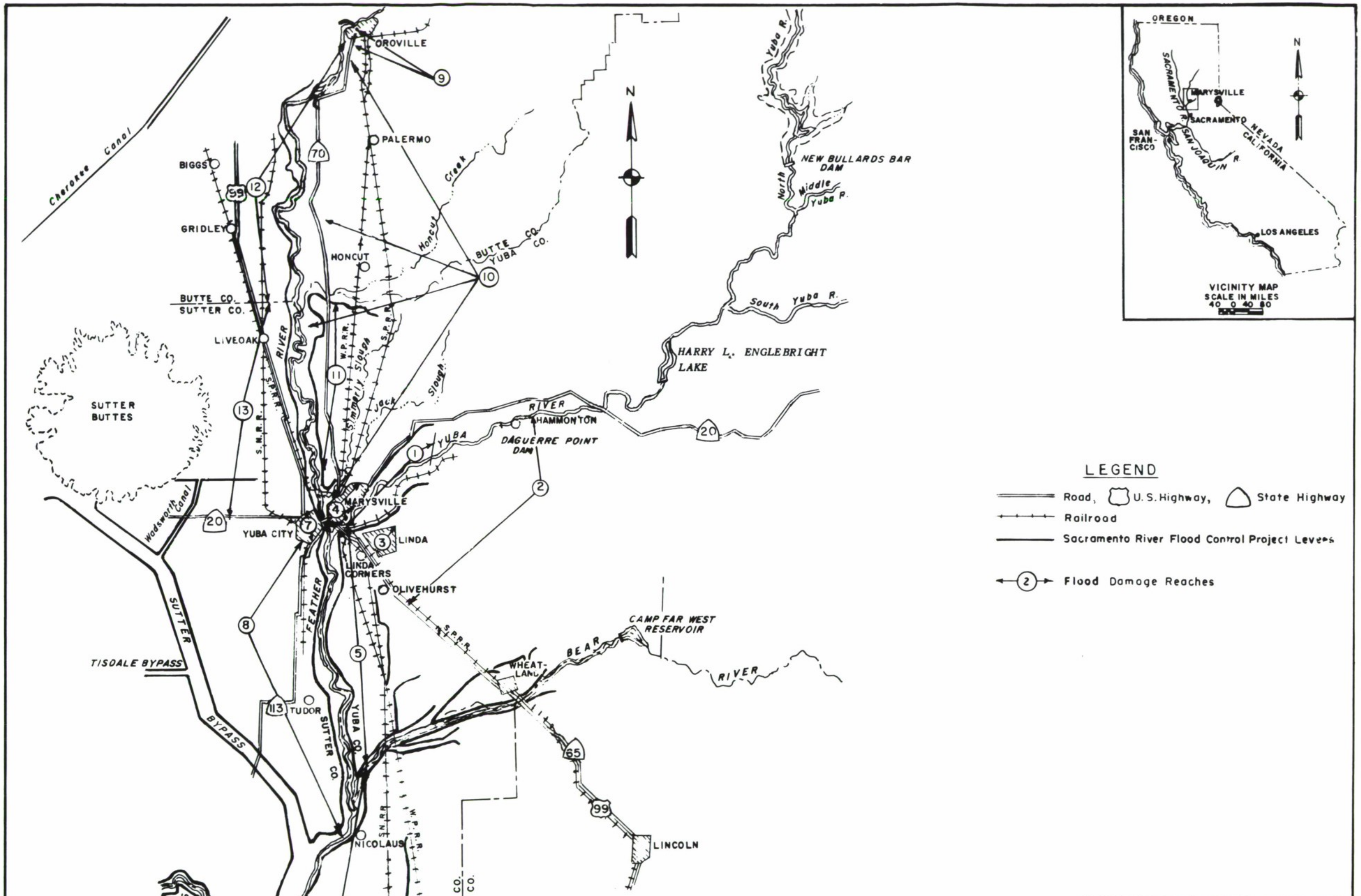


MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

GENERALIZED EXISTING LAND USE
MARYSVILLE - YUBA CITY AREA

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
MARCH 1977

FIGURE K-1

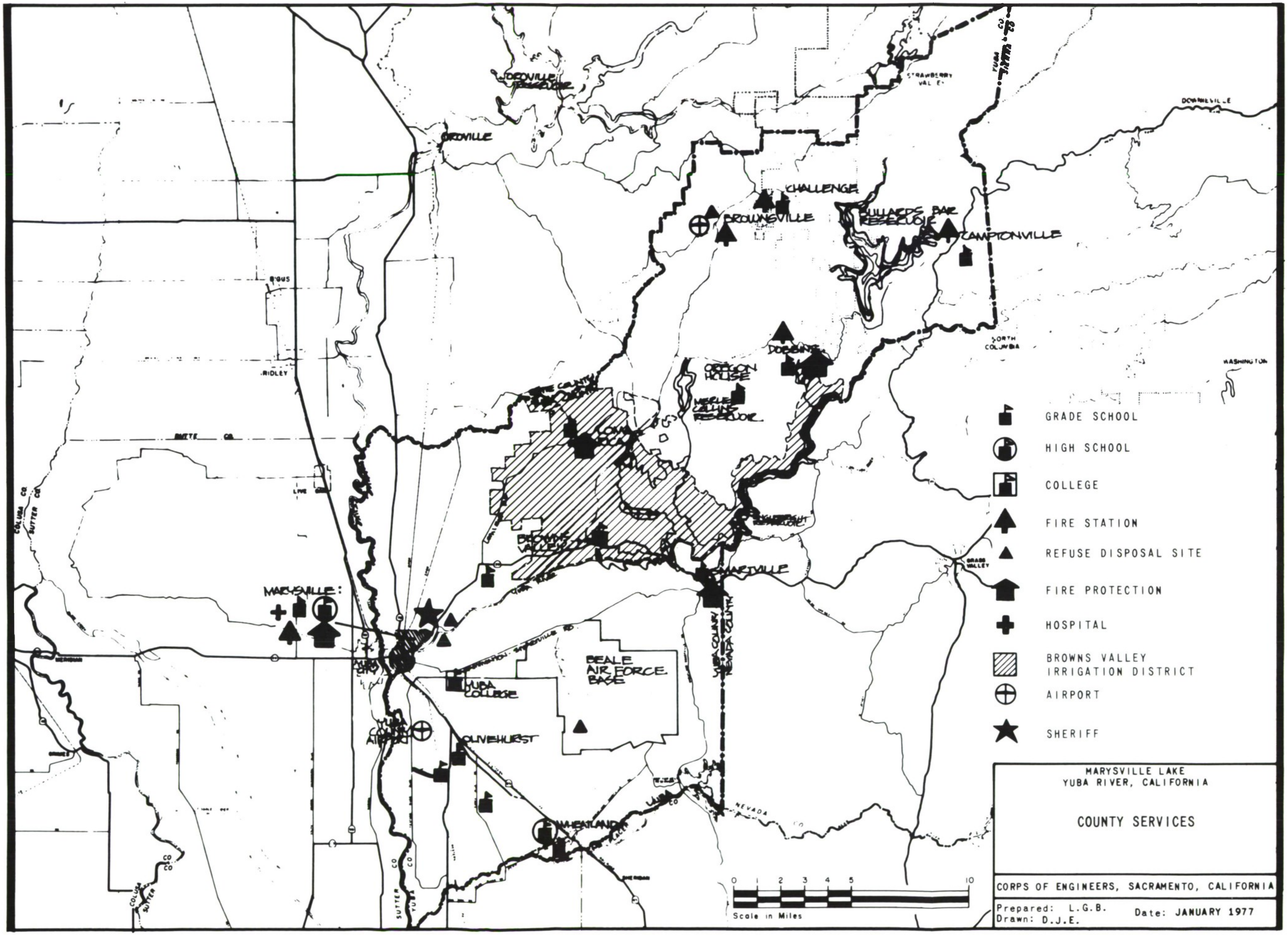


MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

FLOOD DAMAGE REACHES

Corps of Engineers	Sacramento, California
Prepared by: R.L.C.	Date: JANUARY 1977

FIGURE K-2



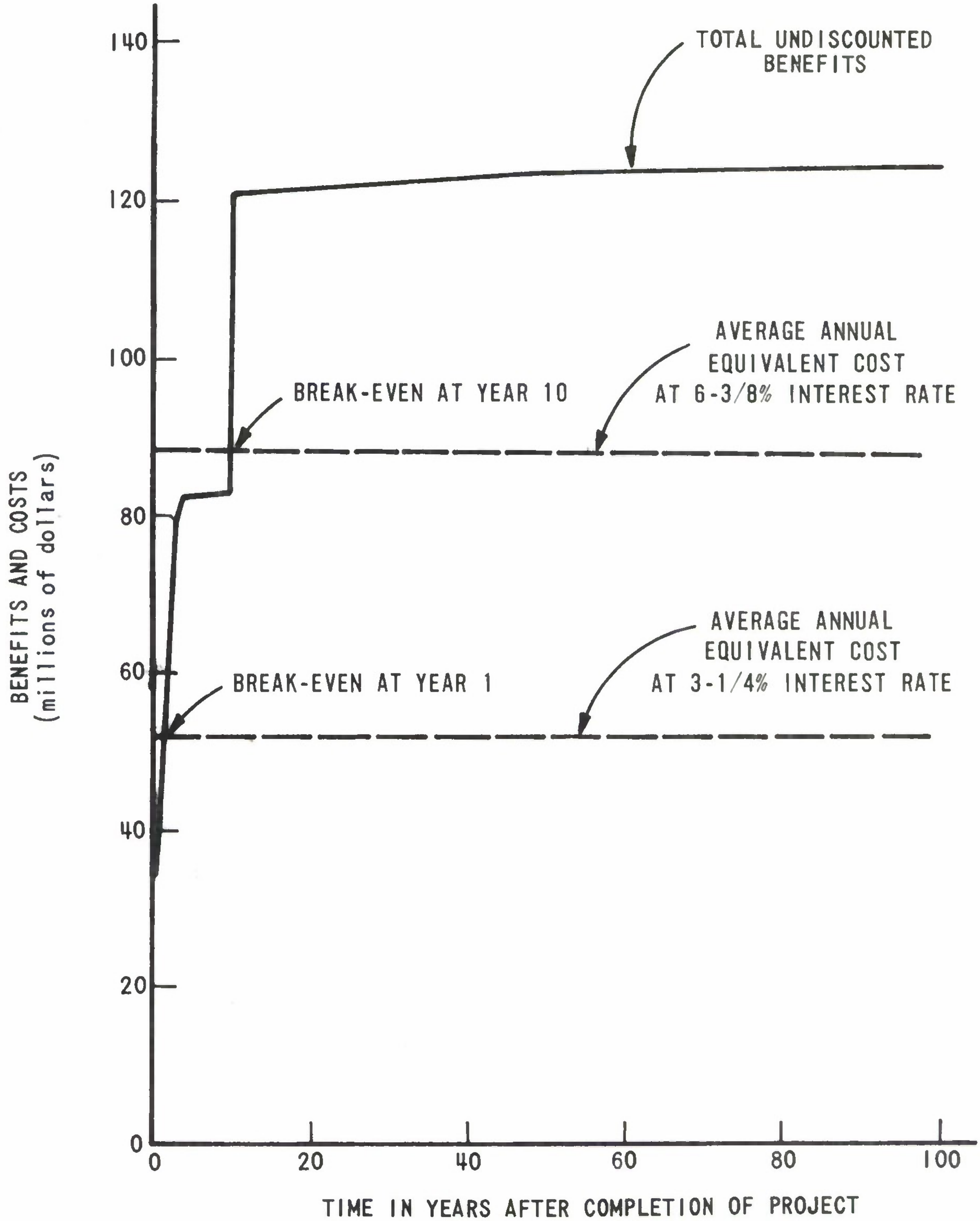
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

COUNTY SERVICES

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: L.G.B.
Drawn: D.J.E.
Date: JANUARY 1977

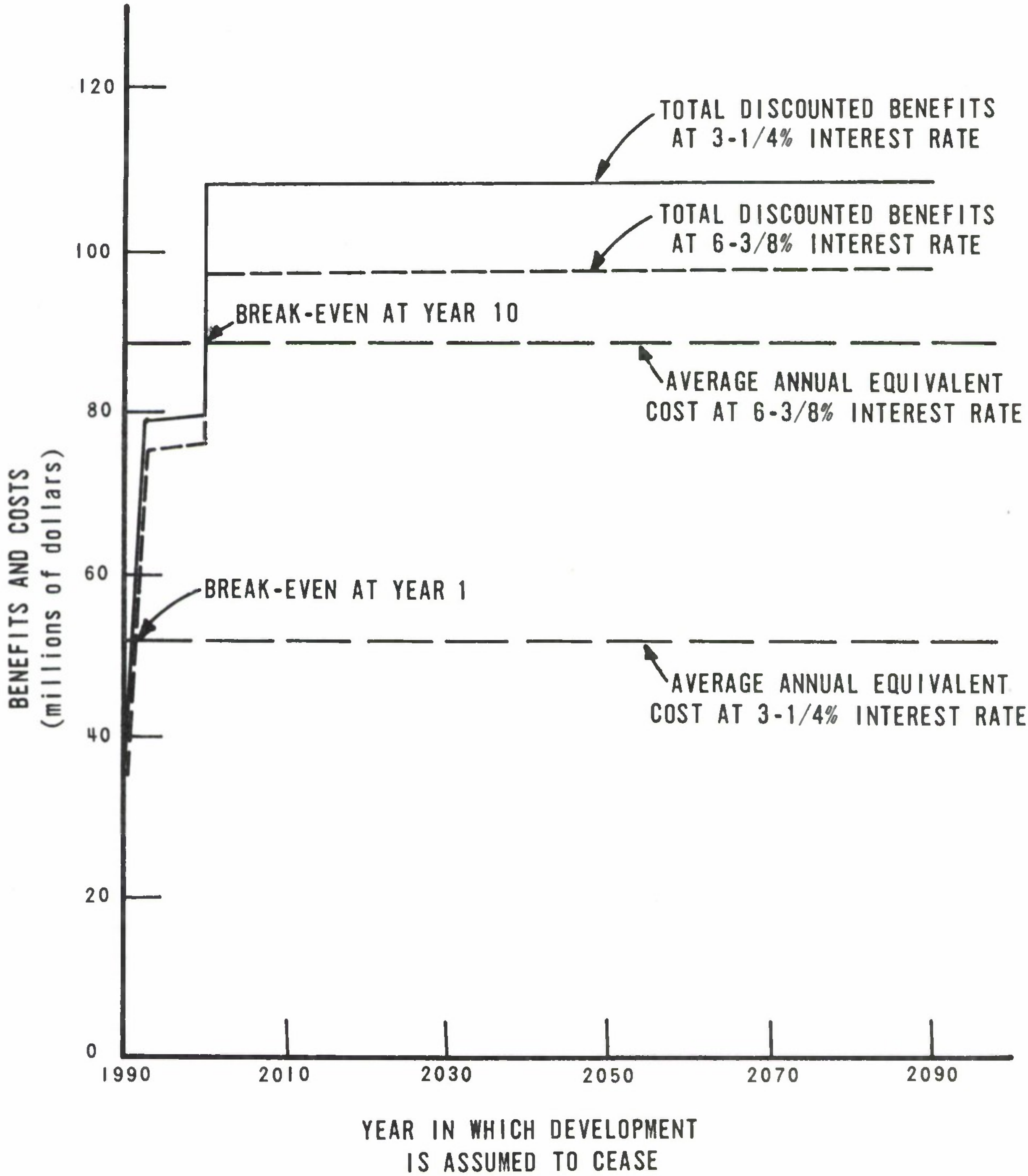
FIGURE K-3



NOTE: ARA BENEFITS OCCUR PRIOR TO COMPLETION OF PROJECT

MARYSVILLE LAKE YUBA RIVER, CALIFORNIA
BREAK-EVEN YEAR UNDISCOUNTED ANNUAL BENEFITS
CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA
PREPARED: B.R.F. DRAWN: L.K.K. DATE: JANUARY 1977

FIGURE K-4



NOTE: ARA BENEFITS OCCUR PRIOR TO COMPLETION OF PROJECT

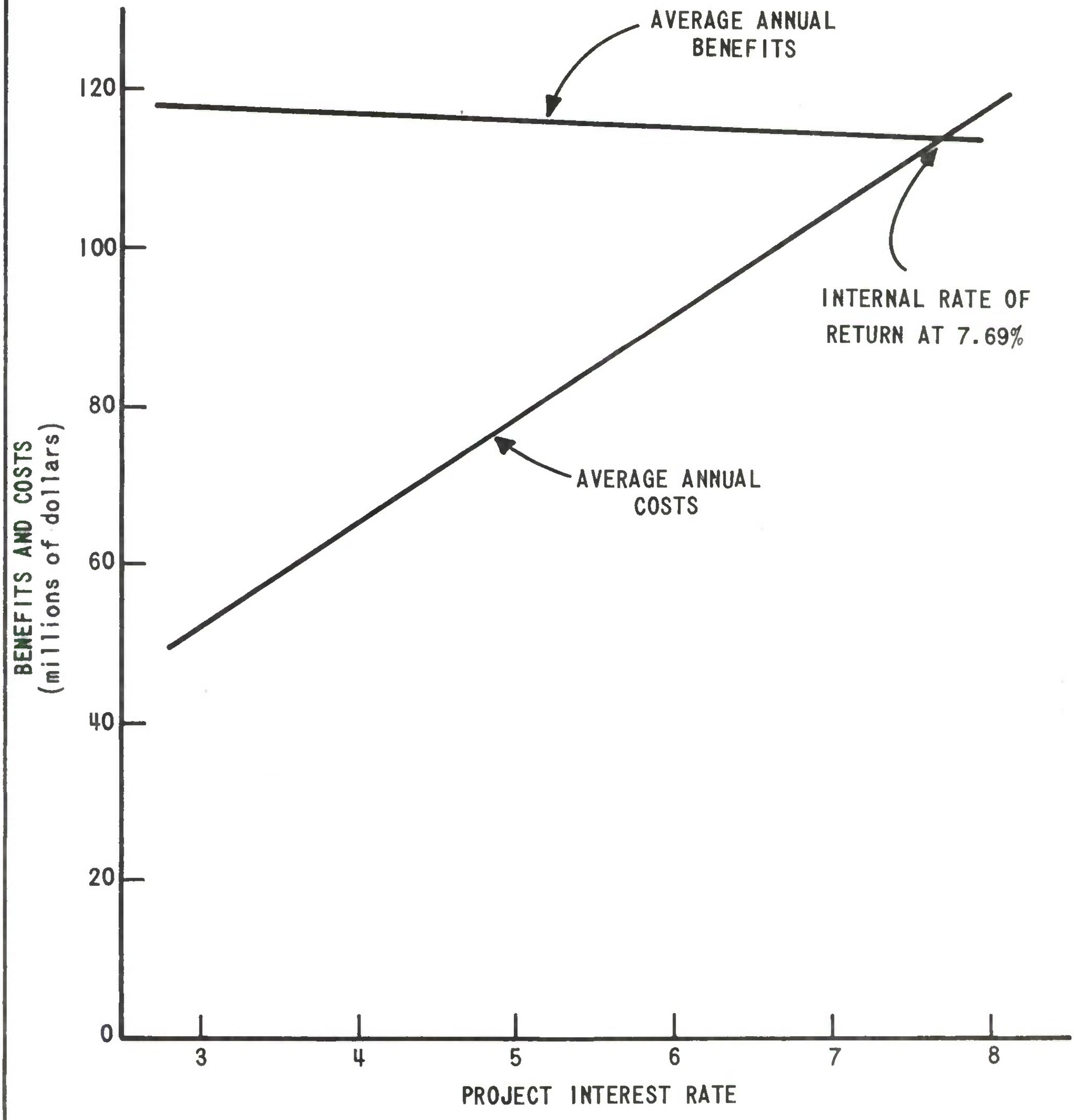
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

BREAK-EVEN YEAR
DISCOUNTED ANNUAL BENEFITS

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: B.R.F.
Drawn: L.K.K.
Date: FEBRUARY 1977

FIGURE K-5



MARYSVILLE LAKE YUBA RIVER, CALIFORNIA INTERNAL RATE OF RETURN	
CORPS OF ENGINEERS	SACRAMENTO, CALIFORNIA
PREPARED: B.R.F. DRAWN: L.K.K.	DATE: JANUARY 1977

FIGURE K-6

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX L -
BASIS OF DESIGN OF SELECTED PLAN

APPENDIX L

BASIS OF DESIGN OF SELECTED PLAN

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APPENDIX L

BASIS OF DESIGN OF SELECTED PLAN

1. Location. -

The Marysville Lake project is a multiple-purpose project and is a unit in the general comprehensive plan for water resources development in the Yuba and Feather River basins. The main dam for the selected plan is located on the Yuba River at the Parks Bar site, approximately 17 miles above the mouth of Yuba River and 5 miles below the existing Englebright Dam. The project lies within both Yuba and Nevada Counties, California. A location map for the project is shown on Plate I.

2. General project features. -

The main feature of the selected plan is a 916,000 acre-foot lake at gross pool elevation of 560 feet above mean sea level (msl), created by construction of a dam on the Yuba River at Parks Bar and a dam on Dry Creek. The principal structures that would make up the project are a combination concrete gravity and zoned embankment dam on the Yuba River, a zoned embankment auxiliary dam on Dry Creek, a connecting channel, a 1,350 megawatt (MW) powerplant with provision for future expansion to 2,250 MW, a zoned embankment afterbay dam, a 15 MW afterbay powerplant, a fish hatchery and spawning channels, administrative facilities, and protective and mitigative measures for cultural and fish and wildlife resources. The

plan is discussed in detail in paragraphs 6 through 29 and shown on Plates I through XII.

3. Topographic surveys. -

Topographic surveying and mapping done for GDM-I studies of the Marysville Lake project are tabulated below. Survey notes and maps are on file in the Sacramento District, Corps of Engineers. This work was done between 1968 and 1976 except for the below water portion of Englebright Lake where the original topographic mapping for that project was fitted to current mapping.

Surveying and Mapping

Feature	Scale	Contour Interval	File No.	Sheets
1. Horizontal and vertical control	1" = 2000'	20' & 25'	YU 4-13-21	1
2. Reservoir mapping Browns Valley and Parks Bar - Dry Creek sites	1" = 400'	10'	YU 4-13-12	30
3. Color aerial photos of Parks Bar and Dry Creek Dam sites	1" = 500'	-	-	-
4. Orthophoto map Browns Valley site	1" = 2000'	-	YU 4-18-17	1
5. Orthophoto map Parks Bar site	1" = 200'	10'	YU 4-18-35	1
6. Orthophoto maps Dry Creek site	1" = 200'	10'	YU 4-18-36	2
7. Orthophoto map afterbay site	1" = 200'	10'	YU 4-18-32	1
8. Mapping Browns Valley site	1" = 400'	10'	YU 4-13-13	1
	1" = 400'	5'	YU 4-13-8	3
	1" = 100'	5'	YU 4-13-7	32
9. Mapping Daguerre Point Dam	1" = 800'	10'	YU 4-13-38	1
10. Mapping Parks Bar site	1" = 1000'	20' & 25'	YU 4-13-22	5
	1" = 400'	10'	YU 4-13-24	8
	1" = 200'	10'	YU 4-13-31	1
	1" = 50'	5'	YU 4-13-28	28
11. Mapping Dry Creek site	1" = 200'	10'	YU 4-13-33	2
	1" = 100'	5'	YU 4-13-28	10
12. Mapping afterbay site (lower Long Bar)	1" = 200'	10'	YU 4-13-33	1
	1" = 100'	5'	YU 4-13-25	8
13. Mapping connection channel	1" = 400'	10'	YU 4-13-37	1
	1" = 100'	5'	YU 4-13-29	4
14. Mapping Yuba River Channel, Rice Crossing to Colgate Powerhouse	1" = 100'	5'	YU 4-13-30	4

4. Area and capacity curves. -

Area and capacity curves for Marysville Lake and the afterbay are based on topographic maps having a scale of 1" = 400' with contours at 10-foot intervals. The area and capacity curves of the afterbay reflect the main dam powerhouse tailrace excavation and the afterbay spillway approach channel excavation. These curves are shown on Figures L-1 and L-2.

5. Geology and foundation conditions. -

a. Regional geology. - Geologically speaking, the project area is in the northern part of the Western Sierra Nevada Metamorphic Belt. The entire belt, which is 20 to 40 miles wide and approximately 180 miles long, consists of a series of northwest trending assemblages of metamorphosed Paleozoic and Mesozoic volcanic and sedimentary rocks that have been intruded by Mesozoic igneous bodies. Locally, this basement complex is unconformably overlain by erosional remnants of a previously extensive capping of Tertiary volcanic rocks and Tertiary to Quaternary sedimentary deposits.

The foothills area is structurally very complex and has been subjected to varying degrees of folding, shearing and faulting. The dominant structural feature of the area is a wide northwest-trending regional shear zone, which may be a northern extension of the Bear Mountain Fault Zone, although the two features are separated by the Rocklin Pluton about 20

miles south of the Yuba River. Their relationship, if any, therefore is not understood. The afterbay damsite lies within the shear zone, which is almost 2 miles wide in this area. The shear zone has been interpreted to represent a melange that separates relatively undeformed volcanics to the west from pillow basalt, dike complex, and intrusive rock of the Smartville ophiolite sequence to the east. Other less prominent shear zones, fault zones, or other linear features with similar orientations are shown on Plate III. They have been mapped and studied in detail and have been explored by trenching as part of a fault evaluation study, as discussed in Appendix H.

b. Areal geology. - The project area is underlain by bedrock consisting of metavolcanic and metasedimentary rocks. The volcanic portion varies from basic to intermediate in composition (metabasalt to meta-andesite) and has a wide variety of textures. They include subaqueous flows with massive to pillowed structure, rocks with amygdaloidal and porphyritic textures, pyroclastic breccias and agglomerates, crystal tuffs and tuff breccias, and metamorphosed volcanic sediments. Isolated remnants of Tertiary terrace gravels overlie bedrock as shown on Plate III. The maximum known depth of the deposit is 84 feet in the upper right abutment at Parks Bar. The right abutment at Dry Creek damsite is partly underlain by similar material, but the terrace remnant is covered by slopewash, and its areal extent is uncertain. It extends to a depth of about 16 feet. Where exposed, the deposit consists of rounded gravels in a tuffaceous sand matrix. Stream deposits are significant at the sites of the Yuba River and afterbay dams,

but are thin and only about 140 feet wide at Dry Creek. At the afterbay site the stream gravels have been worked by gold dredges and have been placed in typical mounded tailing piles except in the stream channel itself. The area underlain by alluvium (tailings) is about 2,300 feet wide, with material depths as shown on the profile on Plate XII. The material is predominantly sandy gravel and cobbles. At Parks Bar the channel section, which is about 900 feet wide, is underlain by stream alluvium consisting of sand, gravel, and cobbles, as shown on the profile on Plate VII.

Overburden ranges from about 1 foot to 10 feet on the right abutment at Parks Bar and from about 10 to 15 feet on the left abutment. At Dry Creek it ranges from about 15 feet on the right abutment to about 12 feet on the left abutment, and at the afterbay site it is shallow to absent on the right abutment and ranges up to about 10 feet on the left abutment. Overburden is a combination of slopewash and residual soil and is typically a reddish brown sandy clay.

Attitudes of most structural features such as bedding, foliation, shears, and faults generally parallel the dominant structural grain of the foothills which trends N 15° to 45° W. Bedding dips moderately to steeply eastward west of the regional shear zone, is nearly vertical through the 2-mile wide shear zone, and, where recognizable to the east, dips moderately to steeply westward at least as far as Timbuctoo Bend just upstream from the Yuba River-Parks Bar damsite.

c. Explorations. - In the late 1950's the California Department of Water Resources investigated damsites in the vicinity of Parks Bar and the Dry Creek damsite. In 1958, the State drilled 8 diamond core holes in various locations at the Parks Bar site and did some limited geophysical work. The same year the State drilled six diamond core holes and eight auger holes at the Dry Creek site. Some generalized information is available from these early explorations.

In 1975, the Corps of Engineers drilled two diamond core holes in the channel area of the Parks Bar site and one hole near the far end of the left abutment. The channel holes penetrated the stream alluvium and 120 feet of bedrock. At the Dry Creek damsite three holes not exceeding 150 feet were drilled, one in the channel area and one on each abutment. Four holes were drilled at the afterbay damsite: a 100-foot hole on each abutment, a 176-foot hole through the alluvium and into bedrock on the right side of the channel, and a 214-foot hole through the dredge tailings and into bedrock on the left side of the channel.

Geophysical exploration was used extensively at all the sites. Seismic refraction surveys were performed along the centerlines of the major project features, and additional lines were run in cost sensitive areas where conditions permitted. The work was done by the Corps of Engineers and two contracted A-E firms.

d. Foundation conditions. - At the Yuba River damsite, the concrete gravity section of the dam would be founded in the Yuba River channel at a

location where two drill holes and numerous seismic refraction lines show alluvial gravels overlying hard metavolcanic rock with seismic velocities in excess of 10,000 ft/sec. The left abutment for the concrete section would require excavation of soil and weathered metavolcanics to reach foundation rock with velocities of 8,000 ft/sec. The right abutment would require 20 feet to 30 feet of excavation to reach similar material. Foundation depths and required excavations are shown on the profile on Plate VII.

Core trench excavation for the embankment section on the left abutment would average 15 feet to reach rock of 5,000 ft/sec velocity. The core trench excavation on the right abutment would average 12 feet to reach similar rock except for the uppermost 1,200 feet of embankment. Remnants of terrace gravels underlie this area, and firm rock was not defined by seismic refraction work. A State drill hole in this area penetrated 135 feet of soils, gravels, and intensely weathered metavolcanics before encountering good rock.

Seismic work along the centerline of the connecting channel indicates that 8,000 ft/sec (approximate limit of rippability) rock lies at an average depth of 10 feet for one-third the length of the channel, at 15- to 30-foot depth for one-third the length of the channel and as deep as 45 feet or more for the remaining one-third, which is mainly the saddle area on which Long Bar road is located.

At the Dry Creek damsite the channel section and outlet works would require 8 to 16 feet of excavation to remove top soils and alluvial gravels and expose metavolcanic bedrock with seismic velocities in excess of 8,000 ft/sec. On the left abutment the core trench has an average of 12 feet of overburden and intensely weathered metavolcanics for two-thirds of it's length before less weathered metavolcanic rock of 5,000 ft/sec velocity is exposed. The remaining one-third of the left abutment is comprised of two areas where 40 feet and 55 feet of soils and intensely weathered materials overlie rock with velocities of 5,000 ft/sec. Approximately two-thirds of the right abutment and wing dam are mantled by an average of 15 feet of soils and low velocity materials that overlie metavolcanic rock of 5,000 ft/sec velocity. The right abutment also has two areas which are covered by up to 60 feet of low velocity materials before reaching 5,000 ft/sec rock. In one of these areas a core hole penetrated a total of 40 feet of soil and terrace gravels. The remaining reservoir dike areas are expected to be blanketed by 10 to 30 feet of overburden before reaching 5,000 ft/sec materials. Foundation depths and required excavations are shown on Plate IX.

The afterbay dam has an approximate 2,300-foot length in the channel section that is primarily alluvial gravels and dredge tailings overlying hard metavolcanic rock of more than 10,000 ft/sec velocity. At river level on the left side of the channel, the alluvium is up to 100 feet deep and

the tailings are mounded as much as an additional 60 feet. On the right side of the channel the gravels are 34 feet deep, and the tailings are mounded in excess of 30 feet. The left abutment is covered by an average of 15 feet of soils and low velocity materials before encountering rock of 5,000 ft/sec velocity. The right abutment soil cover varies from 1 foot to 10 feet and overlies 5,000 ft/sec rock. Foundation depths and required excavations are shown on the profile on Plate XII.

e. Ground water. - The water table is at river level in the alluvium occupying the stream channels at all three damsites. The Parks Bar site has 80 to 90 feet of saturated gravels, and at the afterbay site depths range from 34 feet of saturated alluvium and dredge tailings on the right side of the channel to 100 feet on the left side. Extensive dewatering would be required at both these sites, and due to the depth and width of the channel at the afterbay damsite, a positive cutoff will be used. Saturated alluvium at the Dry Creek site would probably not exceed 16 feet and generally would be more in the range of 3 to 5 feet.

Little information is available for ground water in the abutments of the three damsites or in the connecting channel, but existing and planned drill holes will provide the means for measuring water levels in the future. It should be noted, however, that local water districts have irrigation canals on the abutments of Parks Bar and Dry Creek sites and water infiltrating from these canals will produce some variations in the ground water levels.

f. Seismicity. - Prior to August 1975, the general position of geologists and seismologists was that earthquakes that might affect the western Sierra Nevada foothill area would originate from distant active faults; the San Andreas Fault to the west, the Sierra Nevada Frontal Fault System to the east, the Midland Fault on the west side of the Great Valley, or possibly from one of the many faults in the Basin and Range Province of Nevada. Historically, moderate to strong earthquakes had originated from these sources, but only one significant earthquake had originated in the northern part of the Sierra Nevada foothills. That earthquake occurred in 1940 from an epicenter 80 km north of Marysville and had a Richter magnitude of 5.7. There were no other historical data or other evidence to suggest that fault structures known to be present were capable of generating significant seismic activity. The Bear Mountain Fault zone, including the regional shear zone that cuts through the afterbay site and the Melones Fault zone, were considered to be long-dead structures with the exception of the northern end, which presumably had generated the 1940 earthquake.

The California State "Preliminary Fault and Geologic Map" published in 1973 shows these fault systems to be pre-Quaternary (older than 2 million years) or having no recognized Quaternary movement. The occurrence of the 1 August 1975 earthquake with its epicenter just south of Oroville (Richter magnitude 5.7) changed the general assessment of seismic risk in the foothill area and has generated several comprehensive studies by State and Federal agencies.

The Sacramento District has contracted with A-E firms for two seismic studies in connection with the afterbay dam and is in the process of completing an in-house fault evaluation and seismicity study for the overall Marysville project. Available information is summarized in Appendix H. Two reports by Woodward Clyde Consultants, "Evaluation for Potential for Earthquakes and Surface Faulting, Parks Bar Afterbay Dam, Yuba County, California," April 1976, and "Evaluation of Seismic Stability, Parks Bar Afterbay Dam, Yuba River California", October 1976, are on file in the District Office. Professors Bruce A. Bolt and H. Bolton Seed of the University of California, Berkeley, were contracted to provide seismic data and design parameters for the Marysville Lake project at the Parks Bar site. Professor Bolt's report, "Seismicity and Seismic Intensity Study, Parks Bar Site - Marysville Lake Project," is summarized briefly in the following paragraphs.

Surface breaks associated with the Oroville earthquake fall in a more or less linear shear zone that projects southward to the Bear Mountain

Fault System. Even if the two faults are considered to form one continuous zone, it is clearly truncated by the Rocklin Pluton which places an upper bound on the length of fault available for rupture, about 45 km from Oroville to the Rocklin Pluton. There is no historical or geologic evidence that extended rupture has occurred, and lack of geomorphological features and the intermittent nature of the shear zone suggest that future ruptures, if any, will be similar to the Oroville offsets. Evidence from exploration trenches indicates a predominantly normal faulting mechanism for the Foothill Fault System and that dip-slip movement has occurred in at least three episodes of faulting in the last 5,000 to 100,000 years with overall vertical displacement of about 45 cm. This suggests that small fault movements of up to 20 cm have occurred with recurrence intervals of 1,000 years or more. From currently used empirical relationships relating possible fault rupture length and displacement to magnitude, Dr. Bolt concludes that an earthquake of magnitude 5.2 to 6.1 $\pm$ 0.3 originating from the shear zone within 15 km of the project site is possible, although the estimate is conservative because there is bias toward the high side in each step of the evaluation.

Considering distant source of seismic activity, three known seismic zones have the greatest potential for generating activity that might be significant at the project site. They are the San Andreas Fault zone, the West Valley (Midland) Fault, and faults in western Nevada. Dr. Bolt believes that these three source areas plus the Foothill Fault zone include all likely earthquake conditions. The following tabulation summarizes the sources and their potential seismic intensities.

Sources and Seismic Intensities

Source	M_L	Distance to site (km)	Site Intensity MM	Est. Peak Ground Accel. ($1 < f < 8Hz$)	Bracketed Duration (sec) ($1 < f < 8Hz$)
San Andreas	8.25	180	IV - V	~ 0.05g	5
West Valley	7.5	80	VII +	~ 0.15g	15
Nevada	7.5	> 80	VII	~ 0.10g	15
Foothills Fault zone	6.25	15	VII - IX	0.35g	20

The most severe earthquake motions to be considered for design purposes will be either a local earthquake generated from the Foothills Fault zone, having a magnitude of about 6.25 and originating about 15 km (9 miles) from the project area, or an earthquake of magnitude 7.5 located on the West Valley fault at a minimum distance of 80 km (50 miles). Drs. Bolt and Seed recommended four accelerograms as representative of the local earthquake. One of these was the accelerogram recorded at the Lake Hughes No. 4 station in the San Fernando earthquake of 9 Feb 1971 scaled to a 0.35 g maximum acceleration. This was used for the local earthquake by Woodward Clyde Consultants to evaluate the stability of the afterbay dam and for preliminary stress analysis of the concrete gravity section.

Data being generated at the present time, as well as data from future studies of the Foothill Fault zone, will be included in future Design Memoranda. The final report of the District's fault evaluation study, complete with maps and trench logs, will be published as an independent document.

6. Hydraulic design. -

a. General. - Functional criteria considered in the hydraulic design of the outlet works and spillway for the Marysville Lake project included objective flow requirements for irrigation and power generation, reservoir regulation requirements for control of the SPF and safe passage of the PMF, downstream temperature requirements for fishery enhancement and irrigation use, emergency drawdown requirements, and diversion during construction.

b. Yuba River main dam. -

(1) Spillway design. - Spillway design was based on a total release capability of 100,000 cfs (80,000 cfs through the spillway and 20,000 cfs through the power facilities) at the bottom of flood control pool (elevation 520.7 feet); a maximum surcharge of 5 feet above gross pool (elevation 560 feet) during passage of the PMF; and a maximum energy flux entering the stilling basin of less than 75,000 horsepower per foot of width. The spillway would be a concrete ogee section with crest elevation 504 feet and net crest length of 330 feet. Spillway releases would be regulated by six tainter gates, each 55 feet wide by 58 feet high. The spillway is capable of controlling releases during the PMF in accordance with the emergency spillway release diagram. Top of dam would be at elevation 570 feet, 5 feet above maximum pool elevation. The spillway stilling basin was designed for a maximum discharge of 450,000 cfs, the maximum outflow during the PMF. The stilling basin would be 380 feet in width and 320 feet in length, with an apron elevation of 155.5 feet.

(2) Outlet works (spillway section). - Outlet works in the spillway section were designed to meet the maximum irrigation and water rights release of 4,400 cfs at elevation 428 feet and to meet downstream water temperature requirements, in the event that releases through the power facilities are curtailed. When the reservoir pool is above spillway crest elevation 504 feet, releases to meet irrigation temperature requirements would be made by opening a tainter gate. Below crest elevation, releases would be through wet wells constructed under each of three piers, with intake ports at elevations 450 feet and 240 feet. Each wet well would discharge into a 3.5 feet wide by 7 feet high conduit that exits on the spillway back face. Discharges would be controlled by a bulkhead gate and inside mounted slide gate on each port and a hydraulic slide gate in the conduit. Four additional rectangular conduits would be provided through the spillway section for diversion during construction purposes. These will be plugged at the appropriate construction phase.

(3) Outlet works (power intake). - Each power unit will pass approximately 21,000 cfs at rated head. A total of 5 units (3 inital installation and 2 future additions) would be installed. The power intakes and units will be discussed further in subsequent paragraphs.

c. Dry Creek dam. - The controlling functional criterion for designing the outlet works for the Dry Creek dam embankment was emergency drawdown when the pool is below the connecting channel invert, elevation 400 feet. Other uses for the outlet works include passage of flow during construction

and a small sustained flow (minimum 10 cfs) for stream maintenance. The outlet works conduit would consist of a 4.5 foot diameter RCP at elevation 243.5 feet, transitioning at mid-tunnel to a 3.5-foot diameter steel pipe. The steel pipe would be installed within a concrete-lined access corridor. Discharge control is provided at mid-tunnel by two 4-foot square hydraulic slide gates in tandem. Air supply to the service gate would be supplied by a separate pipe from the conduit exit. The conduit exits into a 12-foot wide by 55-foot long stilling basin, designed for the maximum discharge of 785 cfs at gross pool.

d. Afterbay dam. -

(1) Spillway design. - The spillway was designed for a 1,350 MW power project, with a gross pool elevation of 248 feet, a maximum pool elevation of 253 feet, and a maximum discharge of 450,000 cfs. The spillway would be a concrete ogee section with crest elevation at 193 feet and a net crest length of 267.5 feet. Spillway releases would be regulated by five tainter gates, each 53.5 feet wide by 58.6 feet high. Top of dam would be at elevation 258 feet, 5 feet above maximum pool elevation. The spillway stilling basin would be 256 feet in length and 306 feet in width, with an apron elevation of 107.5 feet.

Modification of the spillway for future enlargement of the afterbay dam to provide storage for a 2,250 MW main dam powerplant would consist of increasing the pier height to the required top of dam, constructing a headwall across each bay, and providing a top seal on the tainter gates. No other

modifications to the hydraulic design of the spillway or stilling basin would be necessary since the increased pool elevations from future enlargement would be maintained only during the summer season, with operation during the flood season continuing unchanged from the 1,350 MW project.

(2) Outlet works design. - Design of the outlet works was based on an irrigation release of 4,400 cfs at minimum pool elevation 193 feet, and the capability of draining the afterbay to elevation 170 feet. The outlet works would consist of a 8.5 feet wide by 15 feet high conduit, located beneath a spillway pier at elevation 160 feet. Discharge would be controlled at the conduit exit by a 25-foot, top seal, radial tainter gate operated by an overhead hoist. A bulkhead gate would be provided at the conduit entrance. In the event the outlet works were temporarily out of service, irrigation releases could be made through the afterbay powerplant or by cracking one of the afterbay spillway gates. With the latter, gaging and control of releases would be less precise but would suffice for limited operation.

e. Emergency drawdown. - The emergency drawdown analysis was based on criteria presented in ER 1110-2-50, "Low Level Discharge Facilities for Drawdown of Impoundments," dated 8 May 1975. Starting storage for drawdown was taken at the top of spillway gates, elevation 562 feet. Inflow during drawdown was based on the average flow of the highest consecutive 4-month historical period: 4,881 cfs for the Yuba River and 250 cfs for the Dry Creek arm. Drawdown was to be accomplished in a 4-month period with the

spillway and outlet works capable of reducing the Yuba River arm storage by 90 percent (to elevation 337 feet) and the Dry Creek arm storage by 90 percent (to elevation 371 feet). Discharge was based on releases through the spillway and power facilities above spillway crest elevation 504 feet, releases through the power facilities and outlet works in the spillway section below elevation 504 feet, and releases through the Dry Creek outlet works below the elevation of the connecting channel (elevation 400 feet). Maximum release during the drawdown was held to 120,000 cfs, the design capacity for the downstream levees. The time required for drawdown to 90 percent of the Yuba River storage was 10 days, and the time required to achieve 90 percent drawdown of the Dry Creek storage was 117 days (110 days were required to drawdown Dry Creek storage from elevation 400 feet to elevation 371 feet). A plot of emergency drawdown is presented in Appendix F, Hydrology, Hydraulics, and Reservoir Regulation. Approximately 90 percent of the afterbay dam storage is above spillway crest elevation 193 feet, therefore, emergency drawdown of the afterbay dam can be achieved within the required time period.

f. Model studies. - Physical and math model studies have been conducted to determine the ability of the project to meet downstream temperature requirements. These were conducted at the Waterways Experiment Station utilizing the WESTEX math model in combination with a distorted physical model and are discussed in Appendix G. The physical and math combination was considered necessary because of the unusual reservoir configuration and the relatively high flow rates for power generation and pumpback. Additional

temperature studies will be conducted during preparation of subsequent design memoranda to assist in optimizing design of the multilevel intake for operational effectiveness, cost and maintenance. The existing physical model will be utilized for these studies with some minor modifications.

Undistorted physical models of the spillways stilling basins for the main dam and afterbay will be required because of the relatively high unit discharges and energy flux. Hydraulic model tests of the outlet works and pumpback through the multilevel power intake will also be required. Exact modeling requirements will not be determined until design studies have progressed further. However, the following hydraulic models will probably be required.

(1) A small scale model (1:120±) of the main dam, including the spillway, stilling basin, outlet works, selective withdrawal facilities for power, and the approach channel would be used to determine the flow distribution approaching the spillway and over the spillway and to obtain a general knowledge of the overall hydraulic action of the main dam portion of the project. Minor structural modifications for improving hydraulic conditions may be feasible with results from this model.

(2) A large scale model (1:25±) of the main dam including the spillway, stilling basin, outlet works, and selective withdrawal facilities for power.

(3) A large scale model of the afterbay spillway and stilling basin.

7. Freeboard. -

All dams were designed to provide 5 feet of freeboard between PMF pool elevation and top of dam; see paragraph 15, Appendix F, Hydrology, Hydraulics, and Reservoir Regulation. In addition, a 3-foot parabolic camber was added on Dry Creek Dam to provide a minimum of 3 percent of embankment height between gross pool elevation and top of dam. All other embankments exceed this without camber.

8. Embankments. -

Three major structures and three small peripheral dikes are required. The main dam at Parks Bar would consist of a concrete gravity dam in the river section, with embankment wing dams tying into the abutments. Dry Creek dam and dikes and the afterbay dam and dike would be embankments. The design of these embankments would be similar to existing dams constructed of gravel (dredge tailings). Design of Parks Bar and Dry Creek dams are compared to designs for Oroville, Camanche, and New Don Pedro dams in the tabulation at the end of this paragraph. The embankments are designed to resist moderate to strong earth motion and include a central impervious core, wide transition zones, a processed drain in the downstream section, and well-graded granular shells. A more detailed description of the embankments and foundation treatment is given in the following paragraphs.

a. Dry Creek dam and dikes. - Plate IX shows typical sections and a profile view of Dry Creek dam and dikes. The dam is designed with a wide

central core, wide transition zones, a downstream interior drain, gravel shells, wide crest, and relatively flat outer slopes protected with riprap. The central core has a base equal in width to about 50 percent of the reservoir height. It would be constructed of plastic impervious materials and founded in a core trench excavated to sound rock. Symmetry, central location, and base width will optimize the core contact and provide maximum soil pressure at the contact. Further, the foundation would be thoroughly grouted to minimize seepage losses and to preclude piping across the core contact. Outside the central contact area, the embankment foundation would be excavated to remove all soil and highly weathered rock. The width of the transition zones is equivalent to 50 percent of the core width upstream and 70 percent of the core width downstream. A 15-foot wide inclined drain connects with a horizontal blanket drain which would be 10 feet thick. The wide transition zones and thick interior drain would be designed to control seepage and prevent piping. The drain would accommodate displacements in excess of any possible. The gravel shells would be compacted to high densities and thus provide essentially incompressible shells of high strength. In addition, the top 23 feet of the shells would be constructed of quarry rock to provide added resistance to the crest. The 40-foot wide crest of Dry Creek dam would be cambered and would provide a freeboard of 13 feet at maximum section and 10 feet at the abutments above gross pool elevation. Dike embankments will be similar to the main dam. A typical section is illustrated with the crest detail shown on Plate IX. The foundation treatment for the dikes would be similar to the main dam.

b. Yuba River dam. - Plate VII shows typical sections and a profile of the Yuba River main dam. The concrete gravity section is discussed in paragraph 9. The embankment section is identical to that for Dry Creek dam, except for camber and the "wrap-around" portion of the dam. Camber of the abutment embankments would not be required since the maximum height of fill will be only 120 feet. Foundation treatment to include grouting would be similar to the foundation treatment at the Dry Creek site. The upstream slope of the wrap-around portion of the embankments is gradually steepened from 2.75 on 1 to 2.25 on 1 at the concrete interface. This minimizes the length of the concrete section and would not adversely affect embankment stability. Wrap around details would be similar to those used for other large composite dams constructed by the Corps of Engineers and will be addressed in Phase II studies.

c. Afterbay dam. - Plate XII shows a section and elevation view of the afterbay dam and the limits of foundation excavation. The section features a wide central core constructed of plastic impervious soils, conservative 12-foot wide transition zones to protect the core, an internal drain, gravel shells compacted to high density, 2 feet of riprap to protect the upstream slope, and 1 foot of cobbles (selected dredge tailings) to protect the downstream slope. The afterbay dam initially would be constructed to top of dam elevation 258 with an 140-foot wide crest. When the powerplant is enlarged in the future, it would be raised to provide a top of dam elevation of 280 with a 30-foot wide crest. This would provide 10 feet of freeboard between the gross pool and top of the dam at each stage of construction and 5-feet of freeboard between PMF pool and top of dam during

initial installation. Below elevation 220, the outer slopes would be flattened from 1 on 2.5 to 1 on 4 upstream and to 1 on 3.5 downstream. This flattening provides additional fill at the toes of the dam and assures the integrity of the dam should minor slumping occur at the toes as a result of moderate to strong shaking. A significant feature of the section is the requirement to place large volumes of engineered fill below streambed. This requirement is based on static and seismic stability analysis of the embankment and foundation. To excavate the loose dredge-worked stream deposits, an upstream and downstream slurry trench would be constructed and the saturated materials dewatered as the trench is deepened. The foundation would be grouted. Details will be determined during design phases.

DESIGN DATA FOR PROPOSED AND EXISTING DAMS WITH GRAVEL SHELLS

DAM EMBANKMENT VOLUME DESIGN AGENCY DATE	STATE LOCATED	MAXIMUM HEIGHT	CREST WIDTH	RADIUS (R) CHORD LENGTH (CL)	RATIO R/CL	SLOPE HORIZONTAL TO ONE VERTICAL				DESIGN STRENGTHS				MATERIAL TYPES		NUMBER OF ZONES	CORE CONTACT TO EMBANKMENT HEIGHT	CORE = % EMBANKMENT	UNIT WEIGHTS OF EMBANKMENT ZONES
						SHELL		CORE		SHELL		CORE							
						U/S	D/S	U/S	D/S	Ø	C (TSF)	Ø	C (TSF)	SHELL	CORE				
Yuba River (abut, emb) 11,200,000 CY Dry Creek 31,500,000 CY US Corps of Eng. Authorized	Cal Cal	120 328	40			(2.00) 2.75	(2.00) 2.25	0.25	0.25	35°	0	32°	0	Gravel (Dredge Tailings)	Clayey Sandy Gravel and Clayey Sand	4 1-Core 1-Trans 1-Drain 1-Rock	0.55	12.5%	Yd Y Ys Core 120,135,140 Trans Shell 135,142,150
Oroville 80,000,000 CY DWR State of Cal 1968	Cal	770	80			(2.20) 2.75	2.00	0.9	0.5 *	38°	0	34°	0	Gravel (Dredge Tailings)	Clayey Sandy Gravel	3 1-Core 1-Trans 1-Rock	0.35	11.2%	Yd Y Ys Core 132,145,147 Trans 125,130,143 Shell 135,137,150
Camanche 10,600,000 CY Bechtel Corp 1963	Cal	183	34.5			(1.75) 2.50	(1.75) 2.25	0.6	0.6	35° 35.6°	0.27 0.20	34.6°	0.1	Gravel (Dredge Tailings)	Clayey Sand	7 1-Core 1-Trans 4-Rock 1-Drain	0.71	30.1%	Yd max Opt Mo Core 120 11% Trans 118 14% Shell 123 12%
New Don Pedro 16,750,000 CY Bechtel Corp 1971	Cal	585	40	3000 1868	1.61	2.70	2.10	0.70	0.30*	39.5°	0	30°	0	Gravel (Dredge Tailings)	Clayey and Silty Sand	3 1-Core 1-Rock 1-Trans	0.58	13.1%	Yd Y Ys Core 123,137,140 Shell 130,135,146 Trans 138,147,151

* Inclined Core ( ) Slope above gross pool

9. <u>Concrete gravity section</u>. -

The selected plan provides for the construction of a concrete gravity dam across the Yuba River at the Parks Bar site with a maximum height from the lowest point of the foundation to the crown of the roadway of approximately 420 feet. The length of the crest of the concrete section, including spillway and the flanking nonoverflow section, is 2,404 feet. Earthfill wing dams extend from the ends of the concrete section to the 570 contour on each side of the river in order to complete the closure. The concrete gravity section would be founded on hard metavolcanic rock which would develop adequate bearing strength for the expected maximum load. The configuration of the concrete section is based on preliminary stability analysis and requirements to facilitate installation of towers, gates, elevators, and other items. The top of dam is 33 feet wide and supports a roadway, both for vehicular traffic across the dam and for gate hoist machinery. Consolidation grouting, as well as curtain grouting, is planned for the foundation under the concrete gravity section to establish an effective barrier to seepage. Galleries would be provided for grouting and drainage. Contraction and expansion joints would be provided to accommodate volumetric changes which occur in the structure after placement. The location and spacing of transverse construction joints would be governed by the details of the structures associated with the dam, such as spillway gate size and temperature tower size, and also by the results of temperature studies and placement methods. A more detailed description of the major features of the concrete structures is given in the following subparagraphs.

a. Nonoverflow section. - The crest length of the nonoverflow section flanking both sides of the spillway was determined by the length required to install the temperature towers on the upstream face of the nonoverflow section and the extension required to contain the embankment wrap section. Five 35-foot diameter steel penstock liners (three for the initial power installation and two for future turbine installations) would be installed in the left nonoverflow section.

b. Spillway. - A gated ogee spillway section is located between the nonoverflow sections of the dam toward the right bank of the river. The spillway would control releases through six 55 feet wide by 58 feet high tainter gates operated by motor driven electric hoist. The top of gate is at elevation 562 feet, providing 2 feet of freeboard above gross pool elevation 560 feet, when the gates are closed. The six gates are separated by five piers 10 feet wide making an overall distance from outside to outside of the end gates of 380 feet. Stop logs, for closure of spillway gate bays to facilitate maintenance, are not contemplated because planned operation of the reservoir results in the pool being drawn down below the spillway crest during normal years. The stilling basin would be of reinforced concrete anchored into the rock foundation and would be 380 feet in width, 320 feet in length, with an apron elevation of 155.5 feet.

c. Temperature towers. - The selected plan would include construction of five temperature towers on the upstream face of the concrete gravity

nonoverflow section of the Yuba River dam. Each tower would serve one turbine or pump turbine in the powerhouse; three towers would be used with the initial installation and two towers would be available for future expansion of the powerplant. These structures would provide for downstream temperature control by permitting selective withdrawal of the correct temperature water from the reservoir.

As currently envisioned, the temperature towers would be continuous from Station 143+75.29 to Station 149+67.79. They would vary in width from 115.25 feet to 120.5 feet, providing a minimum free opening width of 95.25 feet. Five 25-foot high ports would be provided in the reservoir face of each tower, port velocity would be less than 10 ft/sec with maximum power flows.

Trashracks would be placed on the upstream side of the ports and temperature shutters on the downstream side. Trashracks and shutters would be composed of active panels and filler frames to locate the active panels at the ports. The trashracks and shutters would be stacked in slots in the temperature towers with an open shutter panel placed at the port where water is to be taken in. Trashracks and temperature shutters would be serviced by a gantry crane on the temperature towers.

From each temperature tower, power flows would be conveyed through a 35-foot diameter penstock to each individual power unit in the powerhouse. Power intakes have been designed per Value Engineering studies of the power

intake for the Grand Coulee Third Powerplant. Intake stoplogs 36 feet wide x 49.17 feet high would be provided at the face of the dam, and 26 feet wide x 39.17 feet high penstock gates would be provided in the dam. From the downstream face of the dam to the powerhouse, the penstocks would be housed in reinforced concrete boxes. Articulated joints to permit differential movements would be installed at junctions with the dam and powerhouse. Flow-through-disk butterfly valves, 30 feet in diameter, would be installed in each pump-turbine penstock immediately upstream of the spiral case entrance.

10. Powerplants. -

Two powerplants would be built as part of the selected plan: a 1,350 MW capacity powerplant (expandable to 2,250 MW) would be built at the main Yuba River dam at Parks Bar site and a 15 MW capacity powerplant would be built at the afterbay dam at the lower Long Bar site.

The main dam powerhouse would have four bays, one standard unit bay and three pump-turbine bays, housing one 450 MW standard turbine, generator unit and two 450 MW pump-turbine, motor generator units. The empty pump-turbine bay would be used as an erection bay during initial installation. Ultimately an additional pump turbine bay and an erection bay would be constructed and two additional 450 MW pump-turbine, motor generator units installed.

All turbines at the main dam powerhouse would be of the Francis, or radial flow, type. The pump-turbines would be reversible, rotating in one

direction when operating as a turbine to generate power and rotating in the opposite direction to pump water from the afterbay to the lake. Pump-turbines would be started by electrically connecting them to the standard unit at standstill and accelerating the synchromized units to rated speed together.

The main plant generator and motor-generators would have an overload rating of 115 percent, and the turbines would be sized to produce overload capacity at design head. The design head has been selected to provide the widest possible range of operation and maximum power output at low heads. Turbine dimensions have been determined from information in the current literature and fall within manufacturers' indicated capabilities. A low specific speed was selected for the pump turbines to avoid a deep placement, which could adversely affect dam stability.

The main dam powerhouse would be located downstream of the concrete gravity nonoverflow section near the south bank of the Yuba River. It would be positioned immediately adjacent to the stilling basin and would serve as the south wall for that structure. Since this facility requires the deepest foundation, it would be located in the deepest portion of the existing river channel. The downstream end of the powerhouse would coincide with the end of the stilling basin to minimize spill flow effects on power operation and to eliminate the need for a wall between the powerhouse tailrace and the stilling basin. At this location there is approximately a 1 vertical on 4 horizontal slope from the downstream toe of the dam to the draft tube exit floor.

The afterbay powerhouse would have three bays, two for adjustable blade vertical, propeller turbines of the Kaplan type driving 7.5 MW generators and an erection bay. Unit characteristics are shown in the following tabulation. Turbines would be sized to produce generator overload capacity at design head with normal blade setting with the design head set as low as is feasible in order to increase power output at low heads. This is necessary since afterbay gross pool was set to provide for operation of the main powerplant at a 0.20 plant factor, but expected operation would be with a 0.10 plant factor. Thus, normal afterbay elevations would be low.

Power Unit Characteristics

Location	Main Dam Powerplant		Afterbay Powerplant
Unit	Standard turbine generator	Pump-turbine motor-generator	Standard turbine generator
Generator rating, MW	450	450	7.5
Overload rating	1.15	1.15	1.15
kVA at unity power factor	544,700	544,700	9,080
Motor horsepower	-	679,800 (1)	-
Turbine type	Francis	Francis pump-turbine	Kaplan
Horsepower	708,000	632,000 (1)	11,800
Runner dia., inches	328	468/376	115
Max head, feet	367	367	111
Design head, feet	293.6	293.6	74
Min. head, feet	190.8	190.8	37

(1) Pump operation.

Power generated in the main dam powerhouse (initially 1,350 MW, ultimately 2,250 MW) would be stepped up to 500 kV via transformers at the powerhouse for distribution into the power network. Distribution would be made from a 500 kV switchyard located a short distance from the powerhouse; design would provide for enlargement of the switchyard facility at the time the generating capacity is increased from 1,350 MW to 2,250 MW. The power-plant at the afterbay dam would generate 15 MW of power, transformed to 230 kV and distributed into a 230 kV network through a separate switchyard at the downstream end of the afterbay.

11. Dry Creek outlet works. -

The outlet works consist of an approach channel, concrete intake structure, a circular cut and cover conduit with an inside diameter of 4.5 feet transitioning to a 3.5-foot diameter steel pipe upstream of the core trench at the gate control chamber. A general description and controlling dimensions and elevations are presented in paragraph 6. The gate control chamber would house 2 sets of 4'-0" x 4'-0" slide gates in tandem for regulating stream maintenance releases and for emergency drawdown releases. The cut and cover conduit upstream of the control is 769± feet in length, and the steel conduit downstream of the control is 918± feet to the stilling basin. A mechanical equipment building would be provided adjacent to the stilling basin.

12. Afterbay structure. -

The ogee spillway and the afterbay powerhouse would be concrete gravity sections forming part of the dam. The structures would be founded on hard

metavolcanic rock. Consolidation grouting, as well as curtain grouting, is planned for the foundation under these structures to establish an effective barrier to seepage. The powerhouse is described in paragraph 9, and the spillway is discussed below.

a. Spillway. - A gated ogee spillway section would be located adjacent to the powerhouse on the right abutment. The spillway would control releases through five 53.5-feet wide by 58.6-feet high tainter gates operated by motor driven hoist. The top of the gates is at elevation 250 feet, providing 2 feet of freeboard above gross pool elevation 248 feet when the gates are closed. The five gates are separated by three piers 8 feet wide and a 14 foot-6 inch wide combination pier and irrigation conduit section making an overall distance from outside to outside of the end gates of 306 feet. One set of stop logs would be provided for closure of spillway gate bays to facilitate maintenance and inspection of the tainter gates. Provisions would be made in the design to accommodate future modification of the spillway for enlargement of the afterbay dam and the main powerplant, including a reinforced concrete headwall across each bay to store more water in the afterbay. The tainter gates would be initially designed for the higher head, with provisions to modify the top of gate for sealing. A bridge would be provided across the spillway. The stilling basin would be of reinforced concrete anchored into the rock foundation and would be 256 feet in length and 306 feet in width.

b. Irrigation conduit. - An outlet works would be provided to make irrigation and other mandatory releases when the afterbay powerhouse is not

in use and for emergency drawdown of the dam. Functional and dimensional details are discussed in paragraph 6.

13. Connecting channel. -

A channel would be excavated through the saddle between the Yuba River pool and the Dry Creek pool to facilitate the exchange of water between the two pools. The channel would be a trapezoidal shape with invert elevation at 400 feet msl, bottom width of 250 feet, side slopes of 1 vertical on 2 horizontal, and a maximum cut of about 80 feet. The excavated material would be utilized for the embankment sections of the dams.

14. Access roads. -

Approximately 6 miles of new and resurfaced roads are required for access to project facilities. Access roads would lead from the Yuba River dam to the powerplant and between the old State Highway 20, the afterbay dam, and the fish hatchery. A network of access roads, starting at the existing county Sicard Flat Road, would connect the Yuba River dam corporation (maintenance) yard, administrative and visitors center, project manager's residence, and the Dry Creek dam and dikes. The existing access road to the Englebright Dam area would continue in use.

15. Relocations. -

a. Road relocations. -

(1) State Highway 20. - California State Highway 20 would be inundated and cut at several places by the reservoir, main dam and afterbay. The highway relocation would begin near the town of Browns Valley and pass north of the afterbay spillway and dike. It would cross the afterbay at a narrow location and climb through one of the valleys to the south until it reached the Hammonton-Smartville County Road. The relocated State Highway would then generally follow this county road alignment to the town of Smartville where it would join with the existing Highway 20. The total relocated length would be approximately 8 miles and would include two bridges across Dry Creek and the afterbay.

(2) Roads to be abandoned. - The dam, reservoir, and State Highway 20 relocation would require approximately 17 miles of county roads to be abandoned by Yuba County. These are listed in the next tabulation.

Existing Yuba County Roads To Be Abandoned

Road Name	Road Number	Length (Miles)
Bald Mountain Road	219	0.3
Peoria Road	9	4.2
Hammonton-Smartville Road	36	2.3
Timbuctoo Road	259	1.9
Scott-Forbes Road	222	3.2
Township Road	221	2.1
Smartville Road	19	1.3
Diggins Road	261	0.1
Blue Gravel Road	1025	1.5

(3) Peoria Road. - The abandoned road network would be replaced by a relocated Peoria Road and a new road to the U.C. Sierra Foothill Range Field Station. The Peoria Road relocation would begin at the intersection of Marysville and Bald Mountain Roads and would follow the latter alignment for about 1 mile. It would then branch to the south over a new alignment for 2 miles to the existing Peoria Road at the intersection of land Sections 13, 14, 23, and 24. A large culvert would probably suffice for a crossing at Dry Creek since this stream would be cut off upstream by Marysville Lake.

(4) U.C. Sierra Foothill Range Field Station road. - The new Field Station road would begin at the intersection of Dolan-Harding and Township Roads and follow the east side of the lake for about 7 miles to an intersection with the existing Scott-Forbes Road. A new bridge would be required at Dry Creek where it flows into the reservoir.

(5) Pleasant Valley Road. - Pleasant Valley Road at Bridgeport in Nevada County would need to be relocated because an arm of the lake would extend into the canyon of the South Yuba River. A major part of the relocation would be the replacement of an existing bridge which crosses the river at about the same elevation as the reservoir gross pool. A new bridge at a higher elevation would be required. About 0.2 mile of the road would also need to be relocated.

(6) Future studies. - Appropriate relocation measures will be determined in design studies.

b. Irrigation ditches. - Sicard Flat, Ellis, and Smith Bar Ditches would be acquired, as would the lands served by them. The Farm Ditch on the south side of the project would be inundated by the reservoir and supply to users downstream would be cut off. It is proposed to be relocated parallel to the existing Ousley Ditch starting at Smartville for approximately 3 miles and then routed back to the original alignment through a 700-foot gravity-flow pipeline downstream from the main dam. The Browns Valley Irrigation District siphon across Dry Creek at the upper limit of the lake may require modification.

c. Electric power facilities. - The lake would inundate two powerplants on the Yuba River at the Narrows below Englebright Dam, a few miles of 60 kV transmission lines, and several miles of 12 kV distribution lines.

Approximately 9 miles of 60 kV lines would need to be removed from the Narrows-Smartville line and the Colgate-Smartville line. The Colgate-Smartville line would have to be relocated over approximately 2 miles, including at least one reservoir crossing 1,500 feet in length. Two 60 kV lines from Smartville to Marysville and Nicolaus would need to be raised to clear an arm of the reservoir. The line to Marysville would also need to be relocated across another reservoir arm with a 1,700-foot span.

In various parts of the reservoir and afterbay areas approximately 16 miles of 12 kV distribution lines would need to be removed. About 7 miles of 12 kV relocated line would have to be constructed to maintain service in the area.

d. Telephone lines. - Two overhead lines would need to be removed and relocated. These lines extend from the Yuba River dam at Parks Bar to Smartville and from Sicard Flat to the Field Station. Total removal would be about 7 miles. The relocation would include about 5 miles of overhead lines to Smartville and about 0.7 mile of submarine cable across the reservoir to the Field Station.

e. Cemeteries. - An estimated 100 gravesites exist in small cemeteries at Timbuctoo and Bridgeport and in scattered locations downstream of the afterbay and within the afterbay and lake areas. Many have already been identified, but others may be found before the project is completed. All graves and markers would be relocated outside of the reservoir and spillway areas.

f. Solid waste disposal area. - A 24-acre disposal area is located within a mile of the afterbay spillway. The planned relocation includes removal of all waste materials to another disposal site at Beale Air Force Base (AFB); however, the matter will be studied and resolved in design studies.

g. Historical monuments. - Two historical monuments in the area would be relocated because of encroachment by the reservoir. They are the Wells Fargo Building at Timbuctoo and the covered bridge at Bridgeport on the South Yuba River. These relocations are discussed in paragraph 16.

16. Cultural resources restoration and preservation. -

Within the project boundaries there are 430 prehistoric and historic sites. These have been described and evaluated in light of eligibility for possible inclusion in the National Register of Historic Places. Mitigation and protective measures are under consideration relative to the construction of the project and land use plans. Of the total sites, 245 are below and 185 are above the gross pool elevation. Of the 245 sites below gross pool, 132 are historic and 113 are prehistoric. Of the 185 above gross pool, 61 are historic and 124 are prehistoric.

a. Prehistoric. - Prehistoric sites are of several types, including large and small villages, villages with bedrock mortars in association, bedrock mortars with and without slight midden development, rock shelters, and lithic scatters. Some village deposits have surface remains of the characteristic semisubterranean dwellings still evident. All these represent settlements and remains of native peoples ancestral to the Maidu Indians.

b. Historic. - Historic sites derive from two major activities - mining and ranching. Connected with mining are remnants of hydraulic operations, hard rock shafts, rock walls of single and associated multiple structures, water conveyance systems, dams, bridges, mine tailings, power production structures, cemeteries, and townsites. Ranching is represented by rock walls, rock walls of single and associated multiple structures, trash dumps, wooden structures, and dams. In some instances, townsites for example, evidence of multiple functions exist.

All sites have been evaluated in terms of the National Register criteria of significance by consultants, and they have recommended that one prehistoric and one historic district, in addition to 26 individual sites, be nominated to the National Register of Historic Places. A concentration of 133 historic sites along the Yuba River exhibits the entire range of gold mining techniques and appurtenances from the beginning of the Gold Rush period to recent gold extracting efforts. Along Dry Creek, 166 sites constitute the prehistoric district. Many of these are villages and bedrock mortars.

To mitigate against the loss of cultural data, a number of proposals have been suggested. For those sites below gross pool, it is suggested first that a sample excavation program be initiated. Testing would both define the cultural value of the sites and provide the basis for determining what, if any, additional investigation may be warranted in each case. For historic remains, test excavation should be preceded by archival research and oral interviews. It is expected that sample size would vary according to site size, findings, and other factors. For those cultural resources which can be protected, particularly for those above gross pool, a number of preservation measures could be implemented. These include restricted access, placement of a protective overburden, utilization of data and artifacts in interpretive displays, and relocation of some structures.

The mitigation program for archaeological and historical resources would be developed in detail in Phase II GDM studies. Based on studies to date, the program would include development of the following interpretive areas:

- Museum and display areas in the visitor center for samples of materials salvaged and explanation of prehistory and history of the area.

- Development of a prehistoric area in the Deer Creek area consisting of bedrock mortars and a village site.

- Development of a historical mining area in the Deer Creek area consisting of a hard rock tunnel, old roadbed, mining features associated with a water ditch, the O'Conner homestead, remnants of a large historic settlement dating from the 1850's, and other historical sites.

- Development of prehistoric area downstream of Dry Creek dam consisting of numerous bedrock mortar sites and a village site.

- Development of a historic area at Sucker Flat consisting of the Sucker Flat townsite, Blue Point Mine, numerous old house foundations, the hard rock drain tunnel of the Blue Point Mine, and other features of the mine. This area could demonstrate gold rush settlements and a variety of mining techniques.

The program would also include preservation of the following structures:

- Preservation of the old Colgate Powerhouse.

- Preservation of the Little Yuba Powerhouse.

- Preservation (by raising) of the covered bridge at Bridgeport and preservation of the nearby barn.

- Restoration of the Peoria School House to its original condition.

- Restoration of the Rogers House on Sucker Flat.

- Relocation and reconstruction of the partially destroyed Wells Fargo Building in Timbuctoo.

Two structures, in particular, have been brought to public attention as having considerable historic significance - the Wells Fargo office at Timbuctoo, and the covered bridge at Bridgeport. The Wells Fargo Building was constructed in the 1850's and is one of the earlier structures still standing. It is said to have been built of locally manufactured brick. Vandals have destroyed much of it; only one side wall and the front are relatively complete. Currently it is listed as California State Landmark No. 320. The current plan for preserving the Wells Fargo Building is the construction of a replica, using as much of the original materials as feasible, at a site above the reservoir gross pool and within the project area. Relocation of the existing building would be prohibitively expensive because it is constructed of bricks and cobbles held together with a friable lime mortar.

Crossing the South Yuba River is the Bridgeport covered bridge, a single-span wooden structure of combined truss and arch construction built

in 1862 by David Wood. It is recognized as a National Historic Civil Engineering Landmark and is on the National Register of Historic Places. To relocate it to another setting would result in automatic deletion from the National Register. It is currently proposed that the bridge be raised approximately 15 feet to clear the reservoir gross pool. The structure would then have to be reevaluated and renominated for inclusion on the National Register. Alternatives to raising the bridge will be carefully evaluated in Phase II GDM Design studies.

A program would be developed for preservation and mitigation of cultural resources and coordinated with the National Park Service, the State Historic Preservation Officer, and the Advisory Council on Historic Preservation, and detailed cost estimates for an overall cultural resources management program would be developed in Phase II GDM studies. As an example of costs of the program, a preliminary estimate for a 5 percent sample of sites below gross pool would be about $3.4 million. Estimates for the cultural salvage, restoration, and preservation program in this report total about one percent of project costs and include specific costs for restoration of the Wells Fargo Building and preservation of Bridgeport Bridge. Costs for the interpretive areas and preservation of the other structures discussed above are included in the lump sum for archaeological and historical investigation and recovery.

17. <u>Lake clearing</u>. -

The slopes of the lake are predominantly steep and are vegetated with six primary cover types: chaparral, grassland, oak woodland-grass, oak woodland-chapparal, oak woodland-yellow pine, and riparian. These cover

types are charaterized by such plant species as valley oak (Quercus lobata), interior live oak (Quercus Wislizenii), coffeeberry (Rhamnus californica), wild oats (Avena sp.), rye grass (Lolium sp.), and chamise (Adenostoma fascinulata). On north facing slopes, yellow pine (Pinus ponderosa), pacific madrone (Arbutus menziesii) and big leaf maple (Acer macrophyllum) commonly occur.

a. Vegetative clearing. - Vegetation in the lake area will generally be cleared in accordance with ER 415-2-1. Clearing will consist of two zones: Zone 1, ranging in elevation from the canyon bottom up to elevation 496 (10 feet below the 10-year frequency pool), where the recreation shoreline will rarely be exposed, will only be cleared of downed floatable vegetation. Vegetation will be topped off above the upper limit of Zone 1. Zone 2, from elevation 496 up to an elevation somewhere just below gross pool will be cleared of all vegetation greater than 2 inches in diameter and 6 feet high. The exact upper limit will be determined by studies to determine which trees will be able to withstand the anticipated inundation. Zone 2 clearing will not be accomplished in all the lake area. Some areas, selected for importance as fishery habitat and not in conflict with other uses (such as water skiing) will be left uncleared to serve as fish management areas.

b. Structure clearing. - Structure clearing will generally consist of the removal of all floatable materials from below gross pool as well as all concrete-type structures and fences in Zone 2 for hazard reduction to the public. Above gross pool, safety hazards such as open mine shafts and collapsing buildings will be removed. All septic tanks will be emptied and filled in as well as other identified toxins neutralized.

c. Disposal of cleared material. - Disposal of cleared material will provide for maximum public benefit. Some of the cleared material will be used for the construction of fish and wildlife shelters. Use of material for firewood and other marketable wood products will be encouraged to reduce the need to waste or burn cleared vegetation.

d. Coordination. - The clearing plan will be coordinated with all Federal, State, and local agencies and private groups having an interest in this aspect of the project. Input from these parties will be evaluated, and all considerations will be developed into a final clearing plan. The specific details for the lake clearing plan will be covered in a subsequent Feature Design Memorandum.

18. Administration area and visitor center. -

This area will include an administration facility and visitor center; a corporation yard complex consisting of shops, office, warehouse, flammable storage, storage yards, etc,; and operators' residences. The visitor center will include display areas and a museum to inform the public about the project and cultural resources of the area. Additional studies of these facilities and their siting, including alternatives, will be included in Phase II studies.

19. Overlook. -

A downstream overlook will be constructed in the early stages as a construction overlook and will serve later as an overlook of the afterbay.

Detailed studies as to the location, siting, and design will be made during Phase II studies.

20. Recreation facilities. -

Planned recreation development at the lake will be minimal to protect public health and safety. Some of the existing facilities at Englebright Reservoir will continue to be used, including a marina, office building, two restrooms, and parking lots with a combined capacity of 58 cars with trailers or 116 cars. Two existing boat-launching ramps and a 48-car parking lot will be submerged by the Marysville Lake gross pool and will be replaced. The replacement boat-launching ramps will also be longer than the originals so that they will remain functional down to the 10-year low pool elevation of the reservoir.

New recreational facilities at the lake will include road-end development at 13 roads cut off by the new lake. Each road-end development will include a barrier, turnaround area, 25-car parking lot, water well with hand pump, and 2 portable chemical restrooms. Fifteen boat-in campsites and twenty boat-in picnic sites at Englebright Lake would be relocated.

Along the lower Yuba River four public access sites will be developed initially and two will be developed in the future as need arises. Each access area, except Daguerre Point, consist of about 15 acres for day-use activities and would have a 25-car gravel parking lot, provision for car-top

or small trailer boat launching, and portable chemical restrooms. Daguerre Point consists of about 30 acres and would have a 50-car parking lot, eight picnic sites, drinking water, an interpretive shelter and six portable chemical toilets.

21. Fish and wildlife facilities. -

a. Fish hatchery and spawning channels. - The hatchery will occupy approximately 29 acres and will include a residence on the left bank of the Yuba River, downstream of the afterbay dam. A fish ladder will connect the river with a fish gathering tank in the hatchery. The hatchery will provide facilities for producing an adult chinook salmon return of 50,000 fish (a release of 28,000,000 juveniles at 90/lb) and an adult steelhead return of 10,000 fish (a release of 500,000 juveniles at 7/lb). The design will include features to allow for expansion to produce an additional 6,000 adult salmon and 2,500 adult steelhead in the event that mitigation measures are not fully effective. In addition to the hatchery, the fishery program includes implementation of gravel management measures and construction of approximately 2 miles of artificial spawning channels downstream of the hatchery. The channels will occupy approximately 165 acres of land and will provide spawning for approximately 20,000 adult chinook salmon.

A 60-car parking area will be developed to accommodate the initial 100,000 recreation days of visitation. Sixty additional parking spaces would be developed to accommodate the future anticipated use, about 200,000

by 2090. Facilities also will be provided to explain and interpret the fish production facilities to the visiting public.

b. Wildlife facilities. - The wildlife mitigation plan includes planting important wildlife vegetation, managing key wildlife species, and providing additional water sources at the Spenceville Wildlife and Recreation Area. Also, steep gravel banks adjacent to ponds downstream of the afterbay dam will be flattened to encourage growth of riparian and upland vegetation. Nesting sites for raptors would be provided to supplement existing nesting sites in the lower Yuba River and lower Dry Creek area.

22. Hydrologic and communication facilities. -

a. General. - To assure continuous control and proper operation of the project, the hydrologic and communication facilities listed in the following paragraphs will be provided.

b. Pool gages. -

(1) Marysville Lake (Yuba River dam). - A recording pool gage capable of operating over the range from elevation 455 to elevation 565 with an accuracy of .01 foot will be required. This will require a 42-inch diameter floatwell with inlets at about 35-foot intervals. A bubble gage may be substituted. Outside staff gages over the same range will also be required.

(2) Marysville Lake (Dry Creek dam). - Same facilities as above, providing for the operating range of the reservoir.

(3) Afterbay. - Same facilities as above, providing for the operating range of the afterbay.

c. Outflow stream gaging station. - Provisions will be made to continuously measure total flow from Marysville Lake, including a gage on the Yuba River below the afterbay dam and a gage on Dry Creek below Dry Creek dam. A standard gage house and metering cableway will be provided at each site. (Two gages may be required on the Yuba River, one to measure low flow and one to measure high flow.)

d. Outflow station, Cordua Canal. - A stream gaging station will be provided on Cordua Canal just upstream from an existing culvert which is located 1/2 mile below the Daguerre Point. A standard gage house and a metering cableway will be provided.

e. Fish hatchery inflow gage. - A flow meter or measuring flume will be provided.

f. Water temperature gages will be provided at the following points:

(1) Marysville Lake at 20 vertical intervals near the face of each dam.

(2) In the river outlets and penstocks.

(3) In fish hatchery inflow channel (or pipe).

(4) In Yuba River below Daguerre Point.

g. Weather station, including a Class A land pan installation will be located near the project office.

h. Continuous communication (hourly or other frequent interval recording may be used in place of continous recording in some instances) will be provided from the following hydrologic facilities to the powerhouse control room.

(1) Marysville Lake pool gage (Yuba River dam and Dry Creek dam).

(2) Afterbay pool gage.

(3) Fish hatchery gaging station.

(4) Yuba River gage near Marysville.

(5) River outlet and penstock water temperature gages.

(6) Yuba River water temperature gage below Daguerre Point.

(7) Fish hatchery inflow water temperature gage.

i. Daily or more frequent communications to the powerhouse control room will be required from Marysville Lake temperature gages.

23. Real estate requirements. -

All lands required for dams, lakes, recreation, cemetery, and road relocations; fish and wildlife measures; borrow areas; and other purposes will be acquired by the Federal Government. Land required for optimum recreation development would be purchased at the same time as other project lands. The total estimated acreage tentatively blocked out for acquisition is 24,124 acres within the project site and an additional 3,000 acres for wildlife mitigation in the Hackett Creek area (as discussed in Appendix D). The specific acreages required for various purposes are listed in the detailed cost estimate in Appendix M. Fee acquisition is proposed for all project lands. No flowage easements will be required. The real estate acquisition boundary shown on Plates I and II is a tentative line based on sound real estate practice. The estimates were made on a gross basis without benefit of a detailed inspection of each property. Most of the lands are zoned for agricultural purposes.

a. Guide taking-line. - The guide taking-line for the project is in accordance with ER 405-2-150. A minimum of 300 feet horizontal distance above gross pool is provided. This guide taking-line formed the basis for determining real estate requirements for the dams and reservoir exclusive of special additional lands considered necessary for fish and wildlife management, recreation, and road relocation purposes.

b. Surveying and marking project boundaries. - Provision has been made in the cost estimate for survey and monumentation of all project boundaries.

c. Fencing for the project. - It is contemplated that, where needed, project lands in reservoir area will be fenced at Government expense as part of the construction of the project.

d. Englebright Dam and powerhouses. - Englebright Dam is an existing Corps of Engineers debris dam, and there are two powerplants associated with it: the Pacific Gas and Electric Company (PG&E) Narrows I Powerplant and the Yuba County Water Agency Narrows II Powerplant. Englebright Dam and the powerplants would be inundated by the Marysville Lake. Fair market value would be determined for the powerplants and paid the respective owners; this is reflected in the cost estimate. Englebright Dam would be totally removed to below minimum pool elevation 455 and partially breached below that elevation. Since the powerplants would be well below minimum pool, they would not be removed; however, the present owners would be permitted to remove equipment, structural steel, and other salvageable items.

e. New Colgate Powerplant. - New Colgate Powerplant is an existing two unit multiple-jet, vertical-shaft pelton wheel powerplant on the Yuba River immediately upstream from the selected plan reservoir. It is owned by Yuba County Water Agency. The centerline of the pelton wheels is at elevation 565, and the plant currently experiences difficulties operating with water surface elevations above 560.5. The plant was designed for a maximum water surface elevation of 583.

Back water studies made for the project indicate that the selected plan would raise the water surface elevation at the plant above elevation 560.5 with flows above 8,000 cfs when the reservoir is at gross pool elevation. Without the project this elevation is exceeded when flows exceed 18,000 cfs. Water surface elevations at the plant would not be affected by standard project floodflows since preliminary operation studies indicate that peak flows coincide with low reservoir elevations, and water surface elevation at this powerplant during the SPF would be the same as natural (preproject) conditions.

To prevent the Marysville Lake project from interfering with the operation of New Colgate Powerplant, a tail water depression system would be provided. This system would supply compressed air to the wheel chambers, keeping the water surface in those chambers well below the wheels so they may freely turn with discharge water dropping away from the buckets. The units were originally designed for installation of a tail water depression system, but financial limitations of Yuba County Water Agency precluded its installation. The installation of such a unit would make plant operation more flexible and dependable, allowing it to remain in service with flows and water surface elevations that currently force shut down. This would more than compensate the owners for the slight loss in power head from back pressure when the Marysville Lake project raises water surface as well as for the cost of maintenance and operation of the system.

24. Sources of construction materials. -

All embankment and concrete materials are available at or near the site. Impervious fill will be borrowed from the reservoir area, and gravel fill will be excavated from Yuba River dredge tailings. Dredge tailings upstream of the afterbay dam will be processed for concrete aggregate. The larger sizes of concrete aggregate and some sand will be obtained from other sources. Required rock excavation in the connecting channel and from structure foundations will produce riprap. Rock excavated from the connecting channel may also be used for concrete aggregate. The following paragraphs briefly describe the local construction materials.

a. Embankment materials. - Two auger borings upstream of the Dry Creek dam and 11 auger borings in the vicinity of the connecting channel show that residual soils mantle the valleys and gentle ridges. These soils consist of sandy clay and clayey sand with medium to high plasticity and range from a trace to 40 feet thick and average 9 feet thick.

Cased holes advanced through dredge tailings piles penetrated gravels which range from 15 to 76 feet and average 43 feet thick. The dredge piles consist of clean, rounded gravel, cobbles, and some small boulders up to 15 inches in diameter. The plus 3-inch fraction ranges from 5 to 40 percent and averages 17 percent, and the sand fraction ranges from 3

to 28 percent and averages 12 percent. These gravels are typically well graded and can be compacted to very high densities. To meet drain fill requirements, dredge tailings will be processed to remove the sand and cobble fraction. Cobbles processed out of the tailing will be used to protect the downstream slope of the afterbay dam, and the sand will be used to meet part of the requirement for transition fill. Selectively borrowed gravelly sand from the Yuba River flood plain will be used for the bulk of the transition fill.

Foundation borings and seismic refraction surveys show that local bedrock consists of hard metavolcanic rock. Therefore, rock from required excavations will be processed to meet riprap and rockfill requirements. Further, the connecting channel will be widened as necessary to meet rock shell requirements for the top 23 feet of the Dry Creek dam and Yuba River dam embankments.

b. Concrete materials. -

(1) Several cement companies operate within 200 miles of the damsite, all with good product histories, and are capable of supplying the various types of cement that may be required.

(2) The use of a pozzolan in concrete for this project is worthwhile not only because substantial savings in cement can be achieved, but also because this material imparts several desirable effects to concrete, among

them decreased permeability and better durability. At least two commercial sources of good quality natural pozzolans and one or more sources of fly ash are within an economical distance from the project site. Several undeveloped deposits of potential pozzolanic material are located in northern California and Nevada. Preliminary investigations indicate that material from one of these deposits, located approximately 30 miles from the project site, could be used as pozzolan with suitable processing.

(3) An adequate supply of water for mixing, curing, cleaning, and other concrete-related activities is available from the Yuba River.

(4) Preliminary investigations of several sources of concrete aggregate and a thorough exploration of one of these deposits have been completed. Although several of these deposits have not been completely explored, no insurmountable difficulties are expected in obtaining good quality concrete aggregate for the project. The current status of these investigations is outlined below:

(a) Dredge tailings on both sides of the Yuba River, upstream and downstream of the project site, were considered for use as concrete aggregate during preliminary reconnaissance. Tailings downstream from Hammonton, California, were not considered in later investigations due to the relatively long haul distance to the construction site and because these materials did not appear to be of consistently good quality. Preliminary investigations centered on dredge tailings upstream from

Hammonton. Only surface deposits have been considered in these studies. Brief descriptions of the deposits undergoing investigation follow:

- The Long Bar dredge tailings just upstream from the afterbay site can provide most of the No. 4 to 1-1/2" size concrete aggregate required for construction, but only a portion of the sand and 1-1/2" to 4" size material also required; 4" to 6" aggregate is not available in this source. SPD laboratory tests indicate this aggregate is suitable for use in concrete.

- Dredge tailings on the south side of the Yuba River, between Hammonton and Long Bar, could supply additional No. 4 to 1-1/2" size aggregate, as well as potentially sizeable quantities of sand. Explorations are planned for this location.

- Dredge tailings upstream from the damsite, notably the Timbuctoo Bend tailings, are presently unexplored, but could supply some of the + 1-1/2" necessary for the project that is lacking in the tailings downstream. Some sand and No. 4 to 1-1/2" size aggregate is also available.

(b) Natural sand of apparently good quality may be available from various locations near the Yuba River at Marysville, California, a distance of about 14 miles from the project.

(c) All existing quarry sites are unsuitable for making concrete aggregate or are too small. Parks Bar quarry cannot be developed due to its location on the dam axis.

(d) Reconnaissance indicates a quarry might be opened upstream of the site to produce aggregate, but no investigations have been made at this time.

(e) Geological investigation indicates that the aggregate may be obtained from the connecting channel excavation; however, explorations for concrete aggregate have not been conducted in this location.

25. Instrumentations. -

The embankments will be instrumented in accordance with EM 1110-2-1908, part 1 and 2 "Instrumentation of Earth and Rockfill Dams," and the concrete gravity section will be instrumented in accordance with EM 1110-2-4300, "Instrumentation for Measurement of Structural Behavior of Concrete Gravity Structures." Further, the design will include selected instruments recommended in ETL 1110-2-118, "Instrumentation of Joints and Cracks in Concrete Structures" and ETL 1110-2-130, "Seismic Instrumentation of Concrete Dams and Intake Gate Towers." The following paragraphs briefly describe the types of instruments that will be installed.

a. Embankments. - Instrumentation common to each of the three embankments include piezometers, surface monuments, and accelerometers. Piezometers will be installed in the central cores of the embankments to monitor pore water pressure and in transition and drain zones, as necessary, to monitor the head in the interior drains. Surface monuments will be

installed on the embankments to measure postconstruction movements. Accelerometers will be located on embankment crests, slopes, abutments and in the "free-field" downstream of the embankments to evaluate embankment response in the event of seismic activity. To measure interior settlement and deflection during and after construction, inclinometers with telescoping casing will be installed in the Dry Creek and Yuba River dam embankments. Due to the height of the Dry Creek embankment, telescoping casing will also be installed horizontally at selected locations to monitor horizontal strains.

b. Structural. - Instruments include stress meters, strain meters, joint meters, hydrodynamic pressure meters, pore pressure meters, accelerometers, deflection plumb lines and surface monuments. At least three monoliths in the concrete gravity section of the Yuba River dam would be fully instrumented, i.e., an overflow monolith; a full section, nonwrapped nonoverflow monolith; and a nonoverflow monolith wrapped with the embankment section. Other monoliths would be fully instrumented if significant variations in foundation conditions are encountered.

Three accelerometers would be placed in each instrumented monolith: one near the crest, one at mid-height, and one in the grout gallery near the base. Other accelerometers would be placed in the main powerhouse, in the Dry Creek dam outlet works, and in the afterbay dam spillway. Additional accelerometers would be located in the "free field" areas downstream of the dams; where possible these would be combined with embankment instruments.

Pore pressure meters would be used to determine uplift water pressure beneath structures as well as external water pressure on the Dry Creek dam outlet works conduit. Hydrodynamic pressure meters and stress meters would be used to determine loads on structures. Stress meters and strainmeters would be used to monitor structural behavior and distribution of load between elements. Deflection plumb lines would be used to determine tilt of concrete monoliths with various reservoir levels. Joint meters and surface movements would be used to determine relative movement of structural elements as well as postconstruction movements and settlements. Where possible, instruments would be combined with accelerometers to monitor loadings and structural behavior in the event of seismic activity.

26. Care and diversion of water. -

To adequately provide for the care and diversion of water, staged construction is planned at the three damsites. The work will be completed in the following sequence.

a. Yuba River dam 1st Stage

1. Excavate the lower right abutment down to sound rock and prepare foundation of overflow portion of dam. (Work isolated from river channel)

2. Excavate, dewater, and prepare foundation of stilling basin and protect the river side of the excavation with a temporary levee.

3. Construct stilling basin and base of concrete overflow monoliths.

4. Excavate approach and discharge channels.

2nd Stage

1. To protect work area, construct cofferdams with slurry trench cutoffs to bedrock and divert river.

2. Dewater and excavate streambed foundation for concrete gravity dam.

3. Prepare foundation and construct lower portion of concrete gravity dam.

3rd Stage

1. Install low level conduits in overflow monoliths to accommodate normal riverflows.

2. Continue concrete placement with concrete overflow section kept low to accommodate possible overtopping.

3. Excavate and prepare abutment foundations and place embankments concurrently with concrete.

4. Complete concrete overflow section and install spillway gates.

b. Dry Creek dam — 1st Stage

1. Construct outlet works conduit at the lower left abutment. (Work isolated from streambed)

2. Excavate and prepare embankment foundation and begin excavation of the connecting channel.

2nd Stage

1. Place embankment fill on abutments.

2. Divert creek flows through channel formed by abutment fills.

3. Continue excavation of connecting channel.

3rd Stage

1. Complete connecting channel excavation to elevation 400 in order to provide a temporary spillway from Dry Creek to the Yuba River.

2. To insure against overtopping, place embankment in closure portion of dam to elevation 420 in one construction year.

4th Stage

Complete embankment prior to or coincident with gate installation at Yuba River dam.

c. <u>Afterbay dam</u> <u>1st Stage</u>

1. Excavate through the right abutment and prepare foundation of overflow portion of dam. (Work isolated from river channel)

2. Construct stilling basin, base of overflow monoliths, and powerhouse.

3. Construct approach and discharge channels.

<u>2nd Stage</u>

1. To protect embankment foundation area, construct cofferdams with slurry cutoffs to bedrock and divert riverflows.

2. Dewater and excavate half of streambed foundation.

3. Prepare foundation and place embankment to cofferdam levee.

<u>3rd Stage</u>

1. Dewater and excavate remaining half of streambed foundation.

2. Prepare foundation and place embankment to cofferdam level.

<u>4th Stage</u>

1. Complete abutment excavation and preparation.

2. Remove cofferdams.

3. Complete embankment and spillway.

4. Install spillway gates before or coincident with gate installation at Yuba River dam.

27. <u>Beautification</u>. -

A comprehensive architectural treatment report will be prepared by an architect-engineer who will be chosen on the basis of recognized expertise in this field. The report will be initiated after approval of the Phase I General Design Memorandum. It will emphasize compatibility with the

natural surroundings, identification with the cultural environment (possibly by adoption of a central theme), cohesion of the project by incorporating recognizable features throughout, and general coordination of the various features so that this very large project will be efficient in its overall operation rather than being several separate incompatible facilities. In addition to consideration of the architect-engineer recommendations, the beautification guidelines presented in EM 1110-2-38 will be followed. Landscaping, primarily with native species, would be used where appropriate.

28. Operation and maintenance. -

The Marysville Lake project will be operated and maintained by the Corps of Engineers, and will be under the jurisdiction of the District Engineer, Sacramento, California, except that the fish hatchery, spawning gravels, and general recreation areas along the lower Yuba River corridor will be administered by the U.S. Fish and Wildlife Service.

a. Operation. - The Reservoir Control Section of the Sacramento District will be responsible for furnishing reservoir regulating instructions to Construction-Operations Division personnel at the damsite for flood control releases and releases to meet existing requirements and fishery flows. Releases for power and new irrigation water supply will be coordinated with the U.S. Bureau of Reclamation.

b. Fish and wildlife enhancement facilities. - Personnel of the Fish and Wildlife Service will be responsible for operation of the fish

facilities in accordance with general functional goals set to provide enhancement of fish and wildlife resources as affected by this project.

c. Lake recreation and fish and wildlife mitigation facilities. - Initial minimum facilities provided at the lake for public health and safety, the relocated existing Englebright facilities, and fish and wildlife facilities at the lake and at lands specifically acquired for fish and wildlife will be operated and maintained by the Corps of Engineers. Developments at the Spenceville Wildlife and Recreation Area will be operated and maintained by the California Department of Fish and Game.

d. Yuba River corridor recreation facilities. - These facilities will be administered by the U.S. Fish and Wildlife Service and will be operated and maintained by Yuba County.

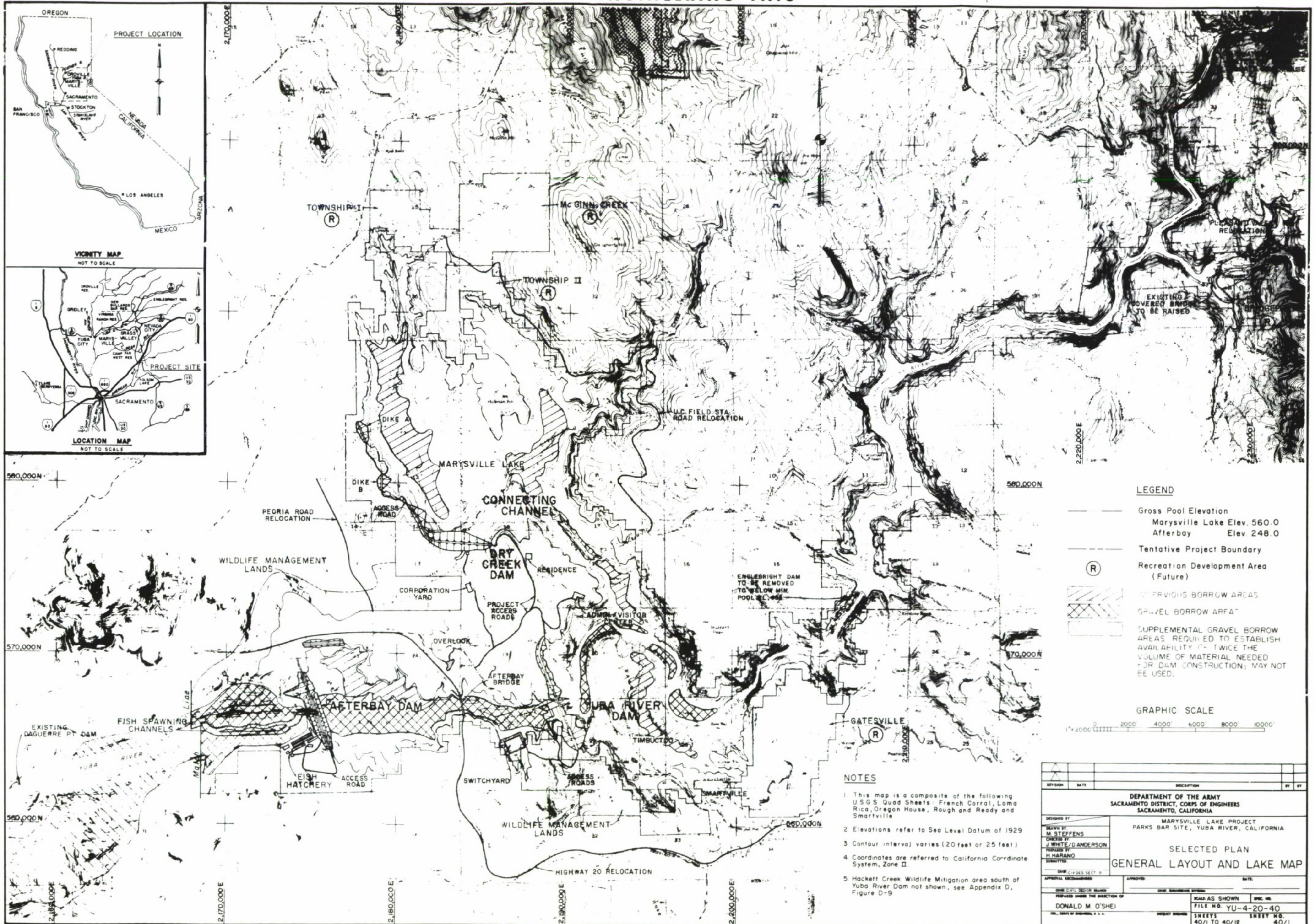
29. Schedule for design and construction. -

a. Design. - Design memorandums presently scheduled are listed on the flyleaf of this design memorandum. Preparation and submission of those memorandums will proceed as closely to the schedule as possible. The project has been planned so that the feature design memorandums and detailed contract plans and specifications can be prepared in sections appropriate to important features of work. Contract plans will be initiated following SPD approval on feature design memorandum.

b. Construction. - With adequate funding, it is estimated that construction of the major features of the Marysville Lake project can be completed within a 9-year construction period. Construction of the project will be accomplished by contracts, except for the installation of certain hydrologic facilities which, due to the high technical skills required, would be performed by Government-hired labor. The relocation of some of the project utilities would be accomplished by the using agencies and reimbursed by the Government. The estimated time required for completion of each major component of the project is tabulated below:

Project component	Estimated time required for completion
Real estate acquisition	8 years
Relocations	3 years
Construction facilities	1 year
Reservoir clearing	2 years
Yuba River dam	7 years
Dry Creek dam and dikes	5 years
Afterbay dam	5 years
Yuba River dam powerplant (initial installation)	4 years
Yuba River dam powerplant (future addition)	3 years
Afterbay powerplant	2 years
Access roads	2 years
Fish and wildlife facilities	3 years
Recreation facilities (initial)	1 year
Administration and other buildings	5 years
Permanent operating equipment	4 years

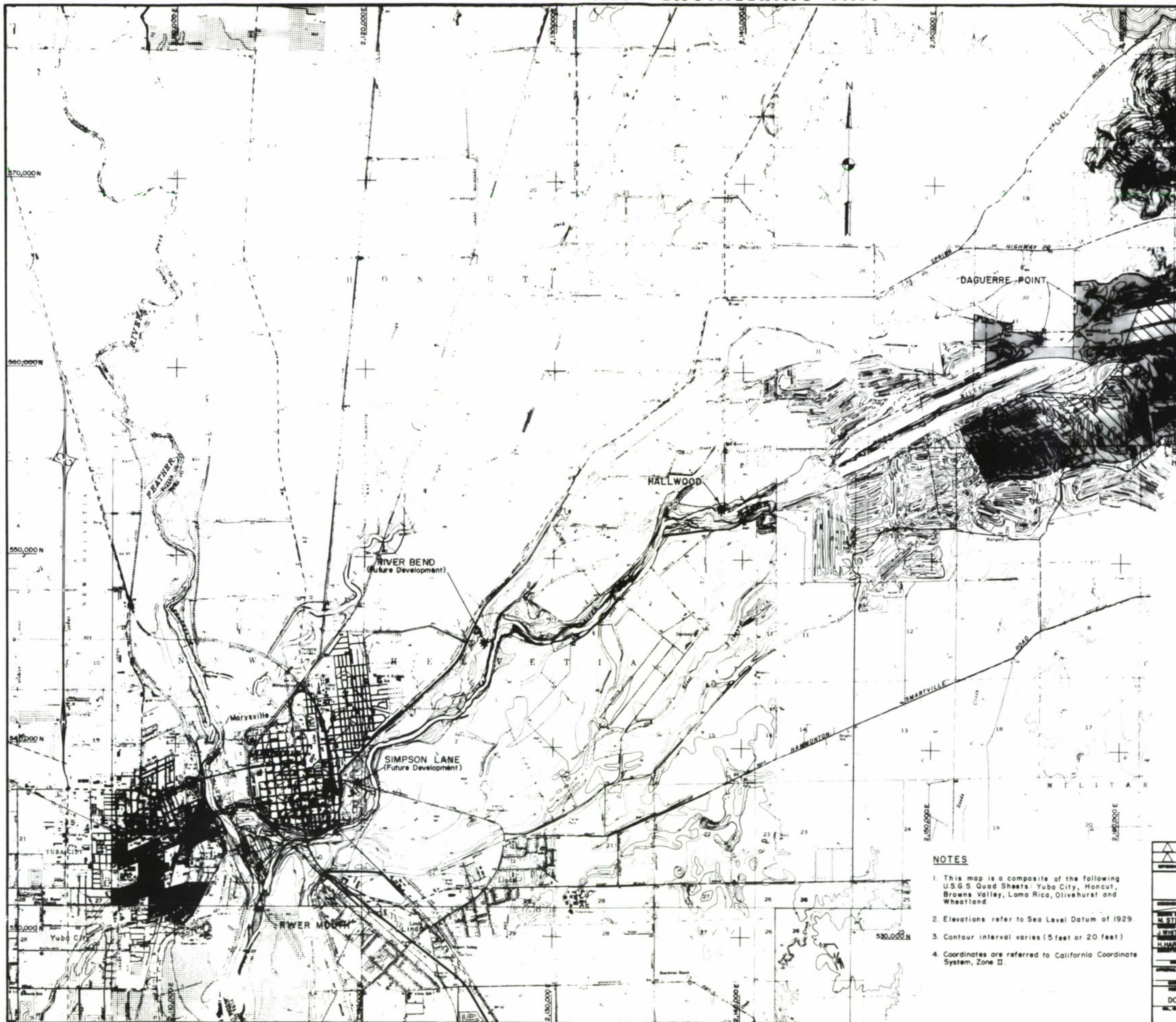
In order to complete the project on schedule and to put power on the line within a 10-year time frame, many of the activities listed above will be accomplished concurrently. The proposed construction schedule by fiscal years and the fund requirements for fiscal years, along with proposed diversion facilities and other details on the proposed construction sequence will be presented in the Phase II GDM. The planned increase in main powerplant capacity would be made when system power needs warrant installation of the additional units, estimated to be in the year 2000.



TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

APPENDIX L

PLATE I



LEGEND

- Tentative Project Boundary
- Recreation Areas
- Fish and Wildlife Management Lands – Currently Government Owned
- Fish and Wildlife Management Lands – Private Lands to be Acquired
- IMPERVIOUS BORROW AREAS
- GRAVEL BORROW AREAS
- SUPPLEMENTAL GRAVEL BORROW AREAS REQUIRED TO ESTABLISH AVAILABILITY OF TWICE THE VOLUME OF MATERIAL NEEDED FOR DAM CONSTRUCTION; MAY NOT BE USED.

GRAPHIC SCALE

1" = 2000' — 0, 2000', 4000', 6000', 8000', 10000'

NOTES

1. This map is a composite of the following U.S.G.S. Quad Sheets: Yuba City, Honcut, Browns Valley, Loma Rica, Olivehurst and Wheatland.
2. Elevations refer to Sea Level Datum of 1929.
3. Contour interval varies (5 feet or 20 feet)
4. Coordinates are referred to California Coordinate System, Zone II.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA

SELECTED PLAN
LOWER YUBA RIVER

M. STEFFENS
J. WHITE/DANDERSON
H. HARANO
DONALD M. O'SHEI

SCALE: AS SHOWN
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12
SHEET NO. 40/2

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

EXPLANATION OF SYMBOLS

QUATERNARY

dt	Dredge tailings. Sand, gravel and cobbles from gold dredging.
Qal	Recent alluvium. Stream channel deposits.

TERTIARY TO QUATERNARY

QT	Sedimentary and volcanic deposits. Undifferentiated along the western margin of map; locally overlies metavolcanic bedrock.
Tc	Tertiary gravels. Auriferous and non-auriferous gravel deposits of uncertain age; locally includes volcanic pyroclastic rocks.
Tg	Terrace deposits. Gravel deposits of uncertain age adjacent to the river channel; locally overlies the Eocene Ione Formation.

JURASSIC TO CRETACEOUS

KJi	Mesozoic intrusive igneous rocks. Includes variations of granite, granodiorite, tonalite, gabbro, diorite, and quartz.

UPPER JURASSIC

Jv	Metavolcanic rocks. Chiefly metamorphosed basaltic to andesitic, pillowed and non-pillowed flows, pyroclastics including crystal and lithic tuffs, tuff breccias or agglomerates, with diabasic to dacitic dikes. Five groups of metavolcanic rocks are described in the project area.

(A) Group A consists of interlayered pyroxene andesite tuff breccias, phyric to non-phyric, pillowed to non-pillowed flows, pyroxene pumice tuff breccia with basaltic to quartz dioritic dikes, finely laminated pyroclastic crystal and lithic tuffs and pyroxene tuff breccia.

(B) Group B (shear zone) primarily consists of actinolite, chlorite, clinozoisite, epidote, quartz, calcite schist (greenschist facies) derived from dynamothermally metamorphosed mafic tuffaceous debris, pillowed to non-pillowed flows, compacted and devitrified rhyolitic tuffs and tuff breccia or agglomerate, intruded by pyroxene porphyritic and diabasic dikes.

(C) Group C consists of pillowed basaltic flows, flow breccia, pyroclastic layered crystal and lithic tuffs and tuff breccia or agglomerate.

(D) Group D is a thick sequence of basaltic to andesitic, pillowed to non-pillowed flows and flow breccias intercalated with pillow breccias and layered tuffs cut by many diabasic to felsic dikes. A gabbro diorite to quartz diorite igneous body occurs inside Timbuctoo Bend.

(E) Group E is essentially a sheeted dike complex consisting of about 70% basaltic to felsic dikes which have intruded pillowed flows, flow breccias and tuffs.

Approximate geologic contact

Regional shear zone boundary

Inferred shear zone boundary

27 Syncline showing troughline & direction of plunge

27 Anticline showing crestline & direction of plunge

80 Strike and dip of fault

IF-1 Vertical NX diamond core drill hole

NOTE

The QT/Jv contact along the western side of the map is generalized from the Geologic Map of California, Chico Sheet (Burnett and Jennings, 1962). Most of the geologic symbols used are from Clark, 1976.

N

This map is a composite of U.S.G.S. quadrangles Loma Rica, Oregon House, Browns Valley and Smartville, California 7.5 minute series.

LOMA RICA | OREGON HOUSE | BROWNS VALLEY | SMARTVILLE

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface | Light-duty road, hard or improved surface

Secondary highway, hard surface | Unimproved road

Interstate Route | U. S. Route | State Route

SCALE 1:24 000

REVISION	DATE	DESCRIPTION	BY	BY

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED BY:
DRAWN BY: D. W. Paige
CHECKED BY: R. J. Anderson
PREPARED BY: R. Treat, J. Gewerth
SUBMITTED: CHIEF, GEOLOGY SECTION

MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA

SELECTED PLAN
REGIONAL GEOLOGY

APPROVAL RECOMMENDED: CHIEF, FDNS & MAT'LS BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE:

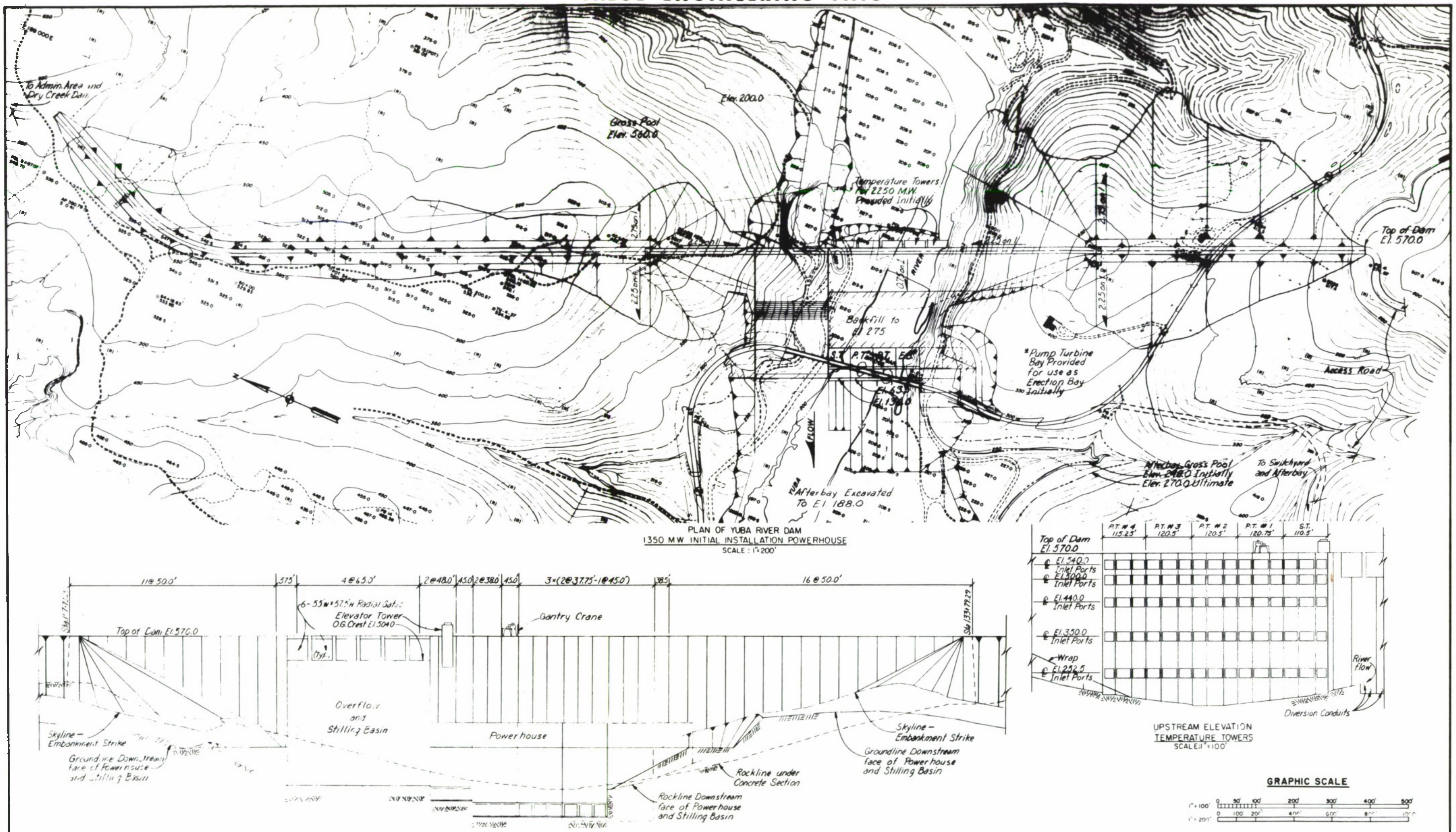
PREPARED UNDER THE DIRECTION OF
COL., CORPS OF ENGINEERS, U. S. A. — DISTRICT ENGINEER

SCALE: AS SHOWN | SPEC. NO.
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12 | SHEET NO. 40/3

PLATE III

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

APPENDIX I



NOTES:
1. The Plan of Main Dam is on Topography from File No. YU-4-13-31/ Sheet 1 of 1.
2. For Concrete Section See Plate X
3. For Embankment Section See Plate VII

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MARYSVILLE LAKE PROJECT
PARKS BAR SITE YUBA RIVER CALIFORNIA

YUBA RIVER DAM
CONCRETE SECTION
PLAN AND ELEVATIONS

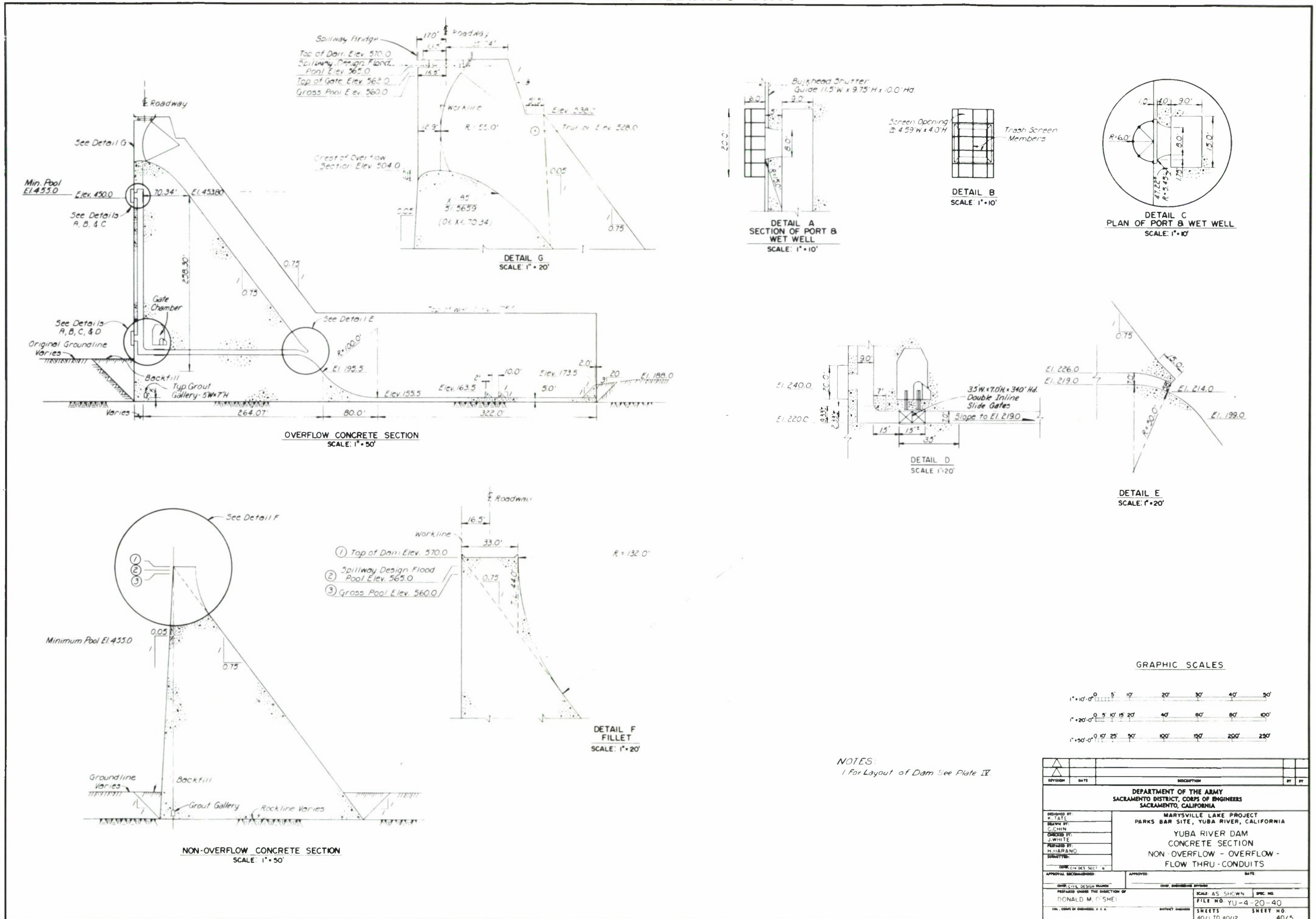
DESIGNED BY: K. TATE
DRAWN BY: K. LEAHY
CHECKED BY: J. WHITE
REVIEWED BY: H. HARANO

DONALD M. O'SHEI

SCALE: AS SHOWN
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12
SHEET NO. 40/4

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION
APPENDIX L

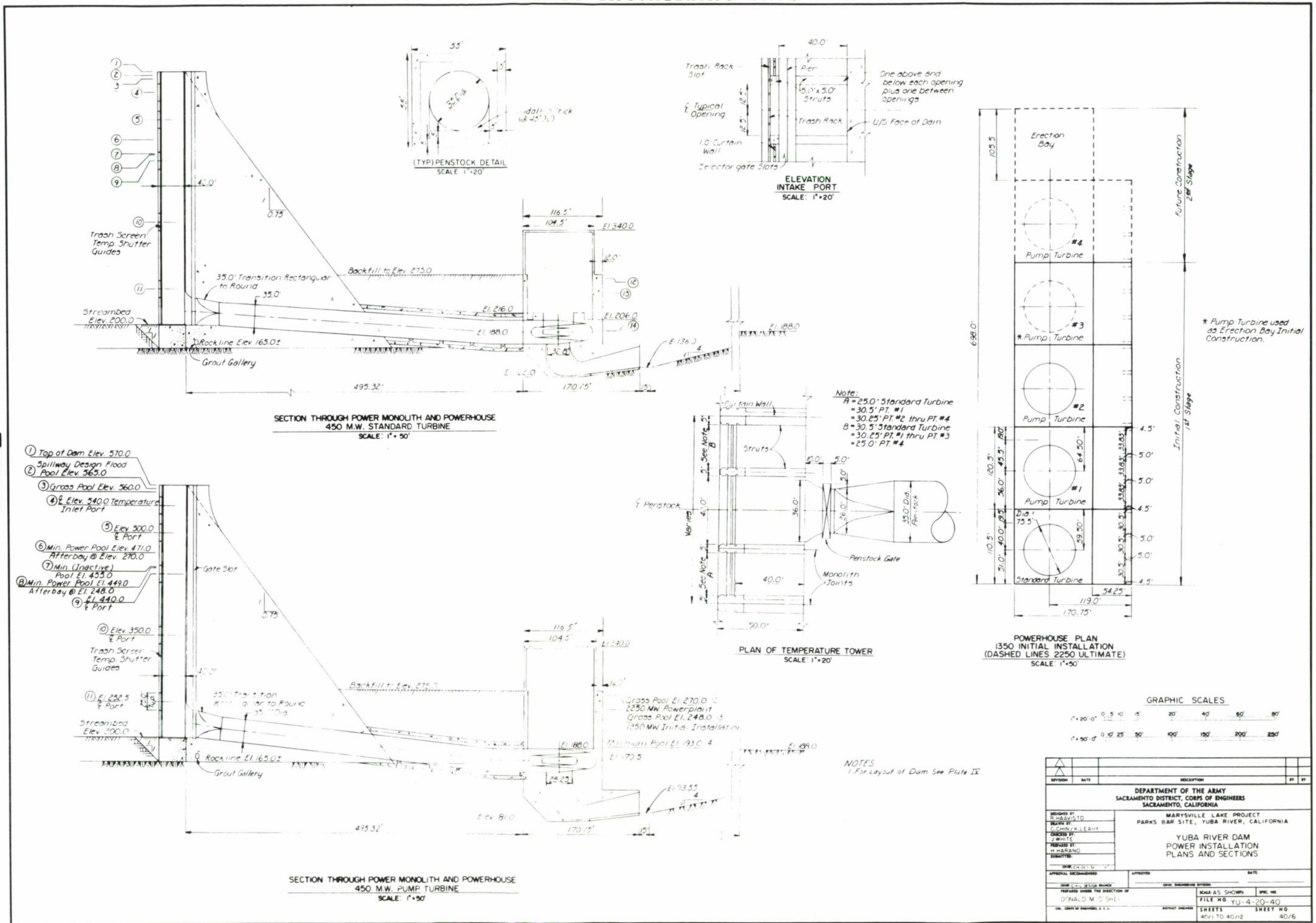
PLATE IV



TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I. PLAN FORMULATION

APPENDIX L

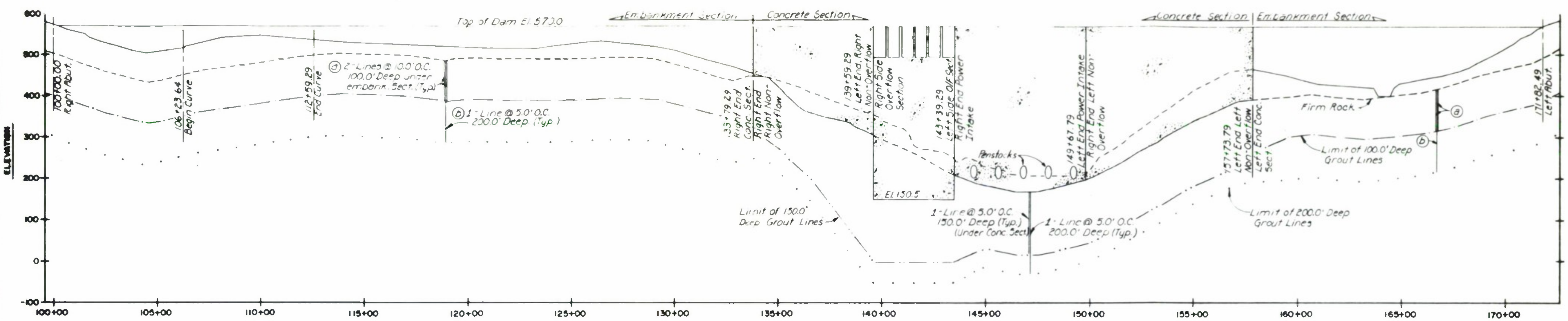
PLATE V



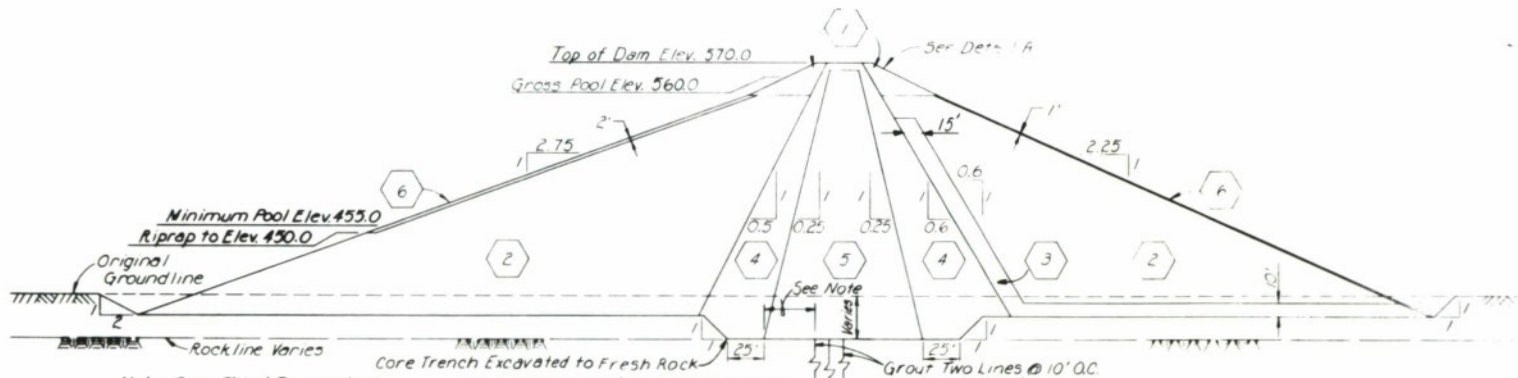
TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

APPENDIX L

PLATE VI



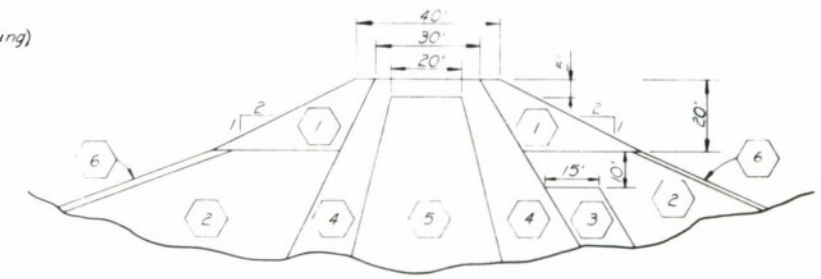
(VIEW LOOKING U/S)
PROFILE OF YUBA RIVER DAM
PARKS BAR SITE
SCALE: 1"=100'-0" VERTICAL
1"=200'-0" HORIZONTAL



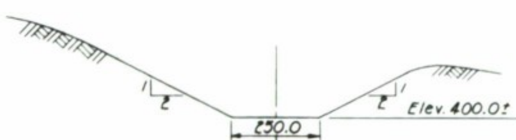
Note: One-Third Impervious Core Contact Width

SECTION OF EMBANKMENT
SCALE: 1" = 50'

ZONE
1 Quarry Rock
2 Gravel Fill-(Dredge Tailing)
3 Drain Fill
4 Transition Fill
5 Impervious Fill
6 Riprap

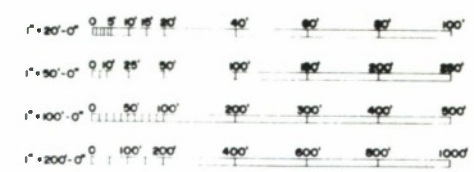


DETAIL A
SCALE: 1" = 20'



SECTION OF CONNECTION CHANNEL
SCALE: 1" = 200'

GRAPHIC SCALES



NOTES:
1. For Layout of Dam See Plate IV

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA

YUBA RIVER DAM
EMBANKMENT
PROFILES AND SECTIONS
CREST ELEV. 570.0

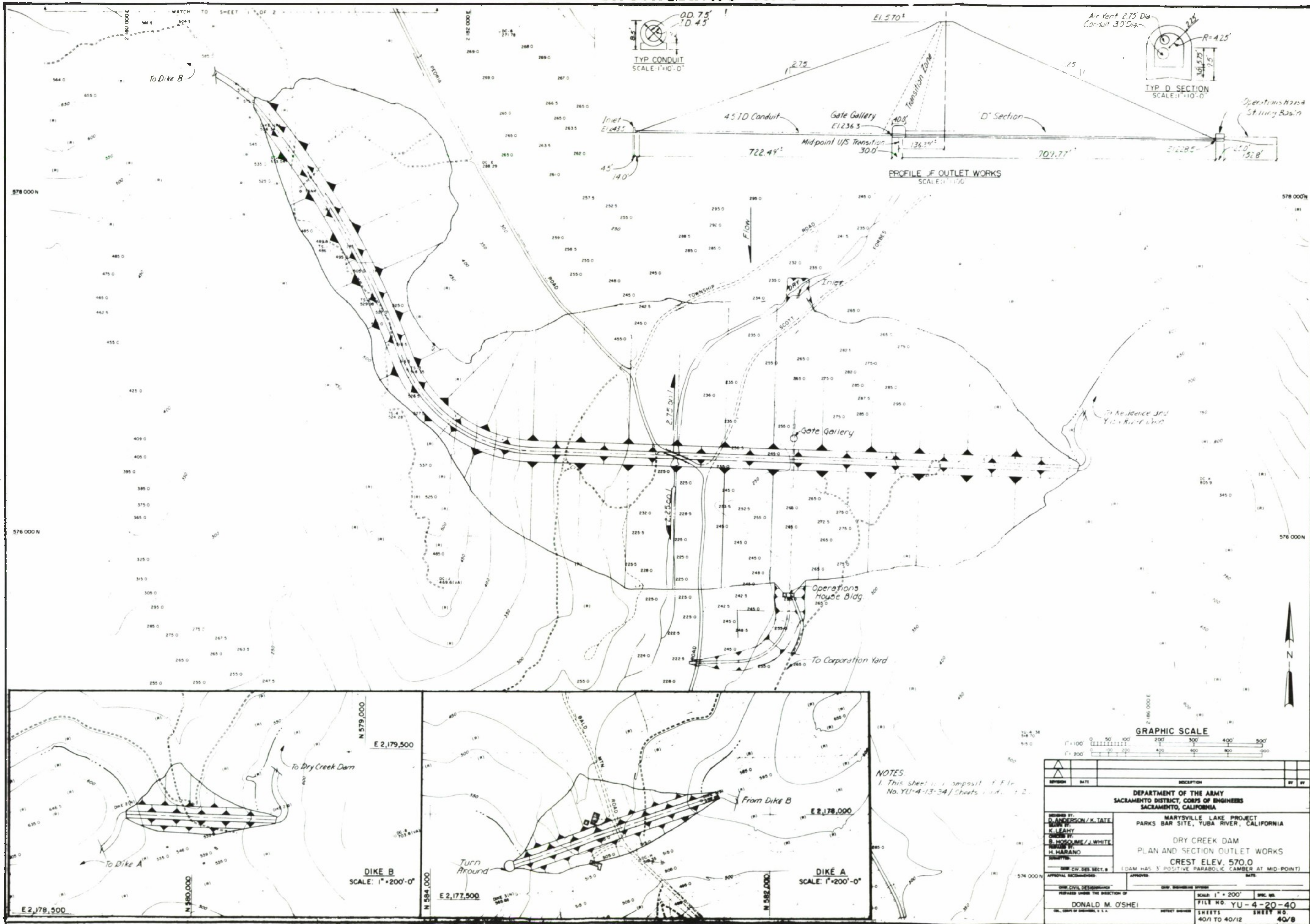
Designed by: D. ANDERSON
Drawn by: C. CHIN / K. LEAHY
Checked by: B. HOSOUME / J. WHITE
Prepared by: H. HARANO

PREPARED UNDER THE DIRECTION OF
DONALD M. O'SHEI

SCALE: AS SHOWN
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12
SHEET NO. 40/7

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I. PLAN FORMULATION
APPENDIX L
PLATE VII

VALUE ENGINEERING PAYS



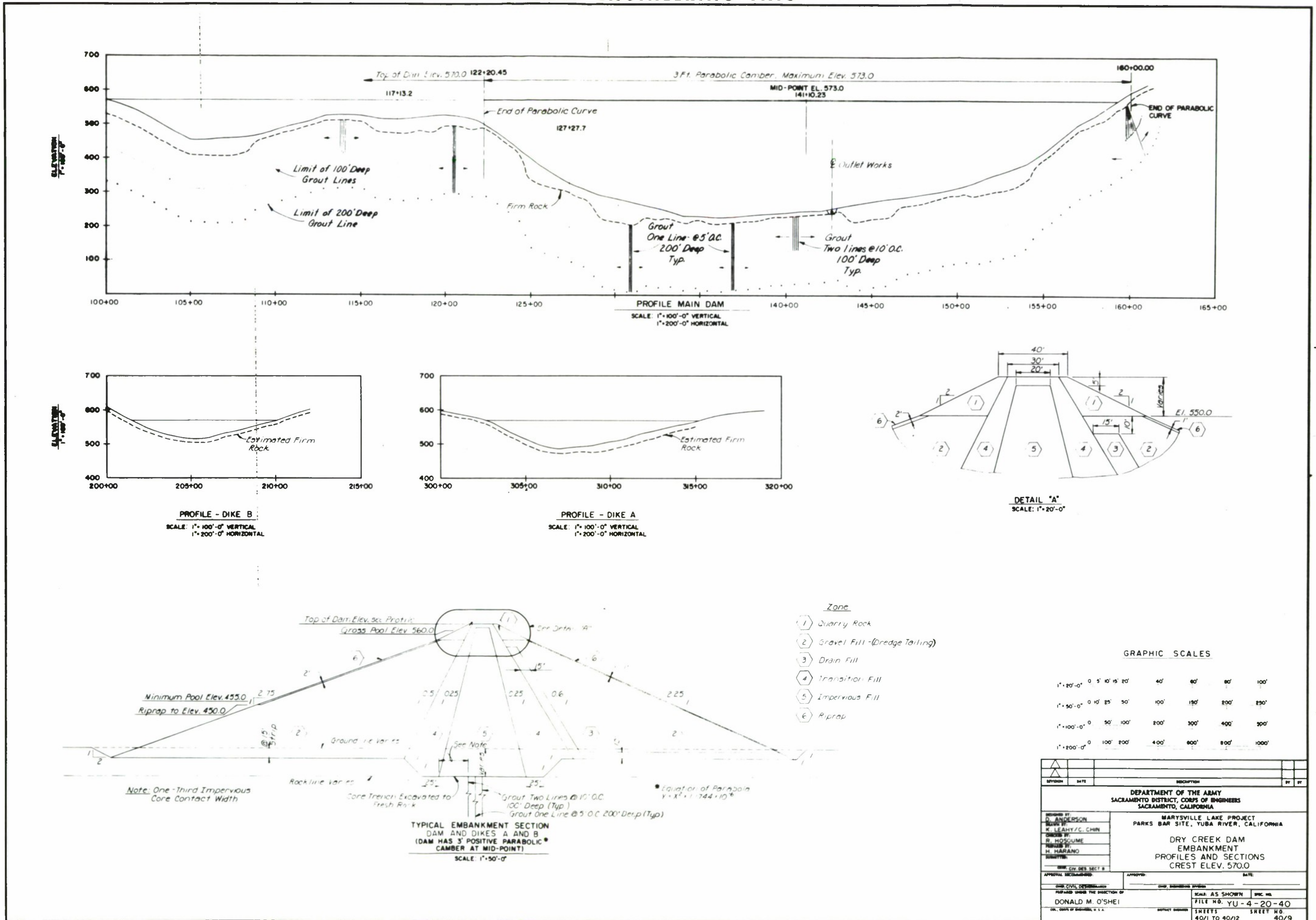
SAFETY PAYS

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

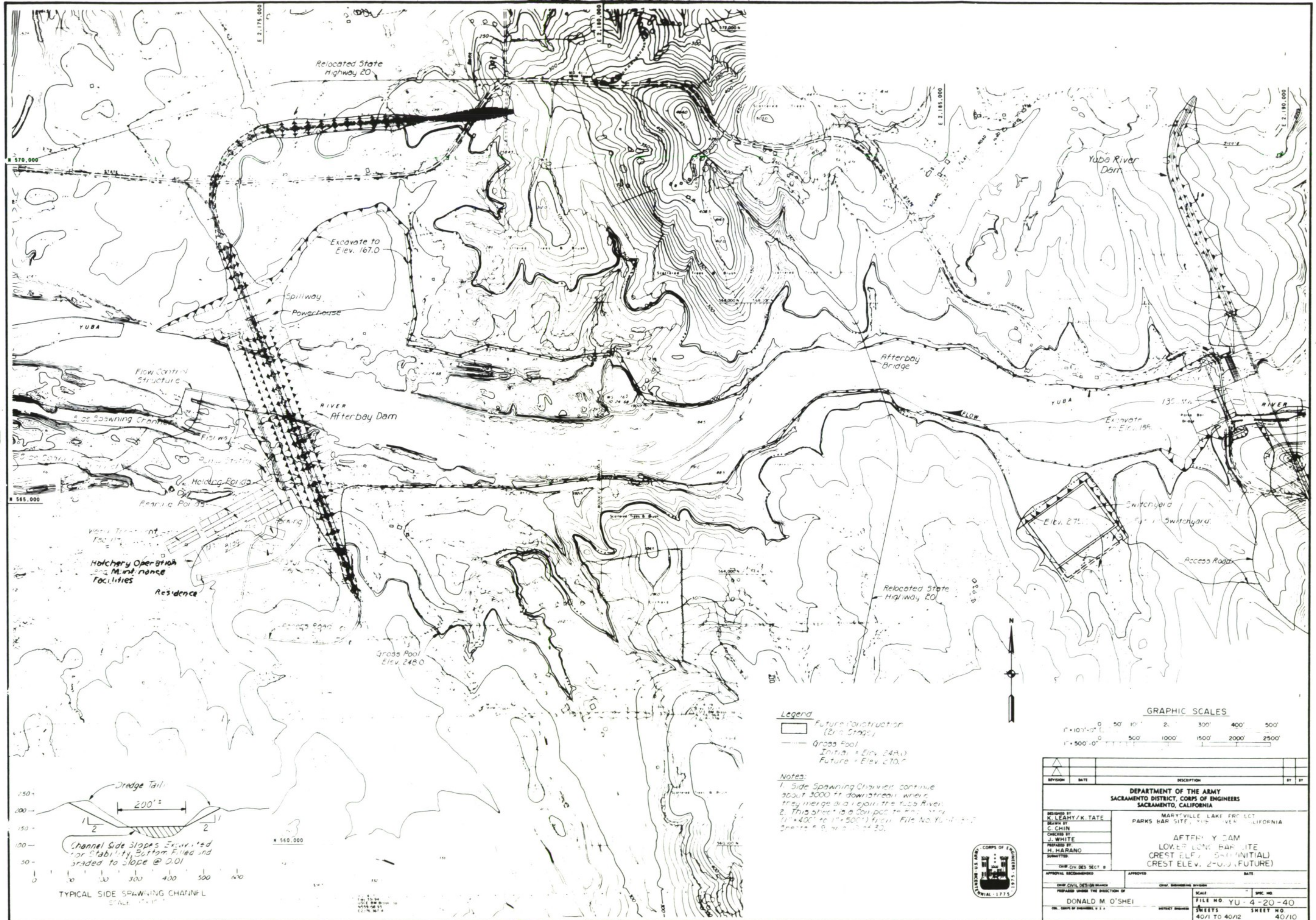
APPENDIX L

PLATE VIII

VALUE ENGINEERING PAYS



SAFETY PAYS

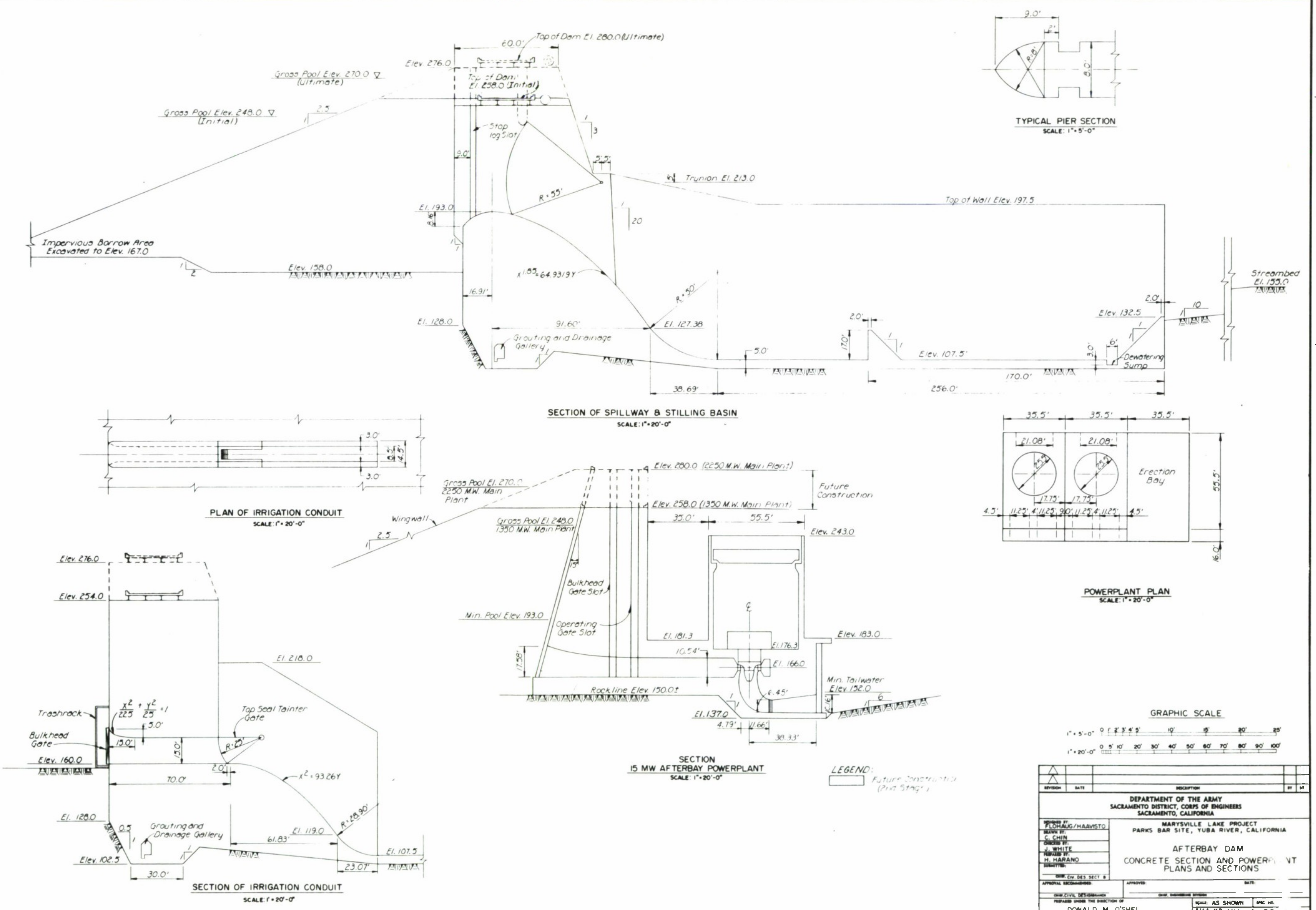


DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA

AFTERBAY DAM
LOWER LONG BAR SITE
CREST ELEV. [illegible] (INITIAL)
CREST ELEV. 2[illegible] (FUTURE)

DESIGNED BY K. LEAHY/K. TATE
DRAWN BY C. CHIN
CHECKED BY J. WHITE
PREPARED BY H. HARANO
CHIEF, CIV DES SECT. B
PREPARED UNDER THE DIRECTION OF DONALD M. O'SHEI
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12
SHEET NO. 40/10



DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

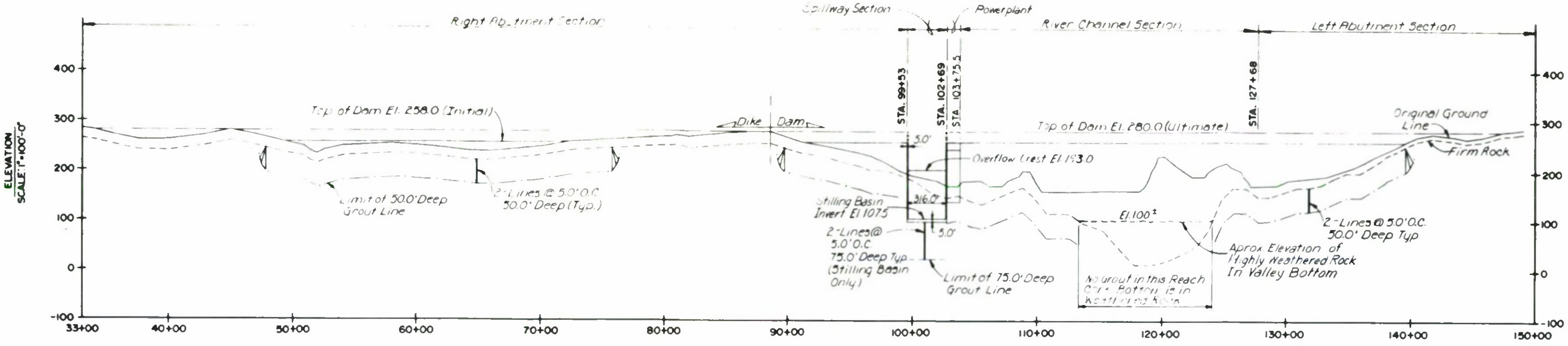
MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA

AFTERBAY DAM
CONCRETE SECTION AND POWERPLANT
PLANS AND SECTIONS

Designed by: FLOHAUG/HAAVISTO
Drawn by: C. CHIN
Checked by: J. WHITE
Prepared by: H. HARANO

DONALD M. O'SHEI

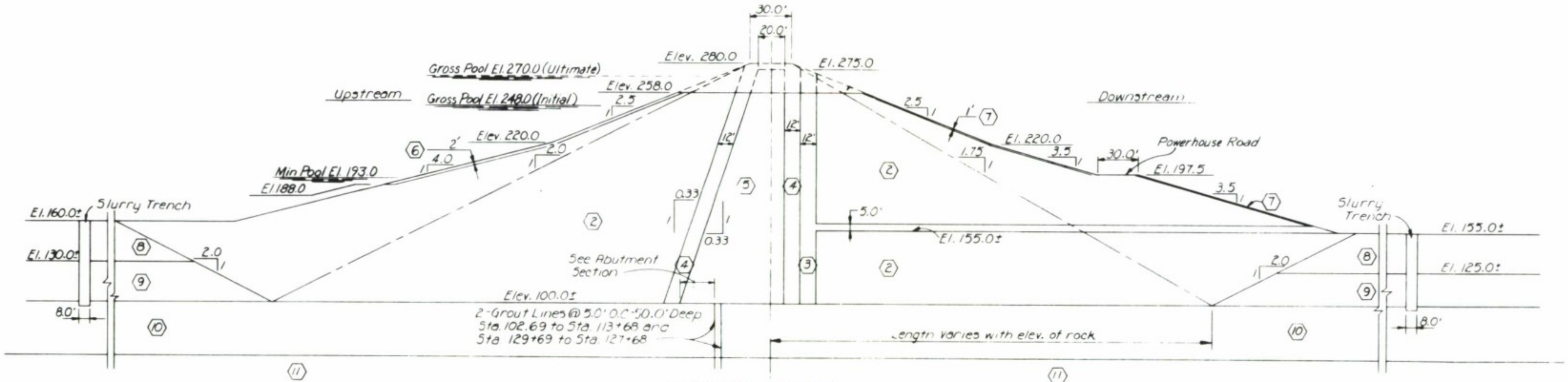
SCALE: AS SHOWN
FILE NO. YU-4-20
SHEETS 40/1 TO 40/12
SHEET NO. 40/11



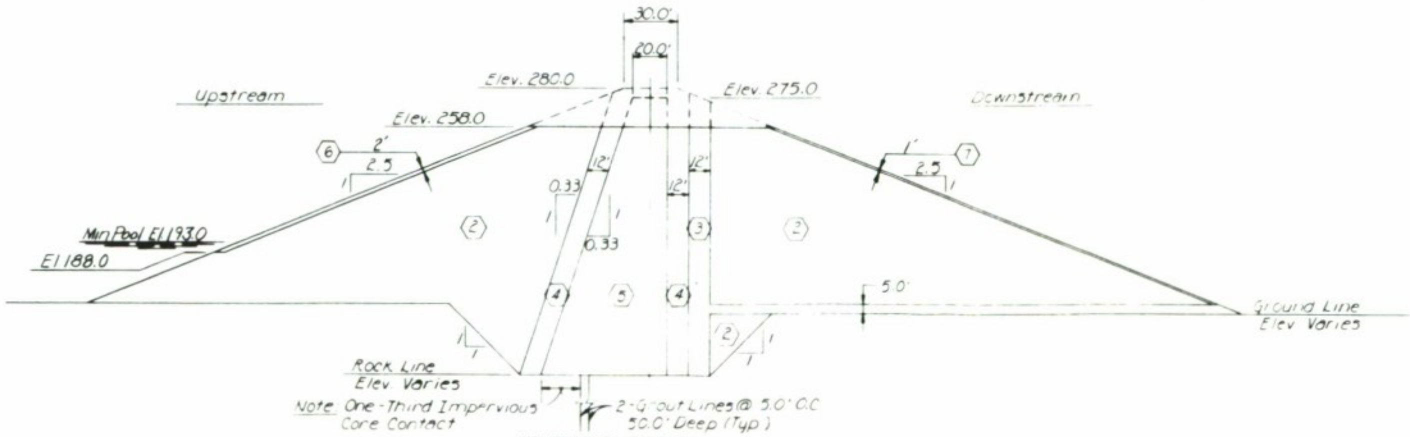
DEVELOPED PROFILE ALONG AXIS OF AFTERBAY DAM AND SPILLWAY (LOOKING U/S)
SCALE: 1"=400'-0"

Zone

(2) Gravel Fill-(Dredge Tailing)
(3) Drain Fill
(4) Transition Fill
(5) Impervious Fill
(6) Riprap
(7) Cobble Slope Protection
(8) Dredged Sandy Gravels (Unconsolidated)
(9) Dredged Sandy Gravels (Consolidated)
(10) Highly Weathered Rock
(11) Firm Bedrock



RIVER CHANNEL SECTION
SCALE: 1"=40'-0"



ABUTMENT SECTION
SCALE: 1"=40'-0"

LEGEND

FUTURE CONSTRUCTION (2ND STAGE)

GRAPHIC SCALES

1"=40'-0" 0 20' 40' 80' 120' 160' 200'
1"=100'-0" 0 50' 100' 200' 300' 400' 500'
1"=400'-0" 0 200' 400' 800' 1200' 1600' 2000'

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

Designed by: D. ANDERSON
Drawn by: C. CHIN/K. LEAHY
Checked by: J. WHITE
Prepared by: H. HARANO

MARYSVILLE LAKE PROJECT
PARKS BAR SITE, YUBA RIVER, CALIFORNIA
AFTERBAY DAM
EMBANKMENT
PROFILES AND SECTIONS

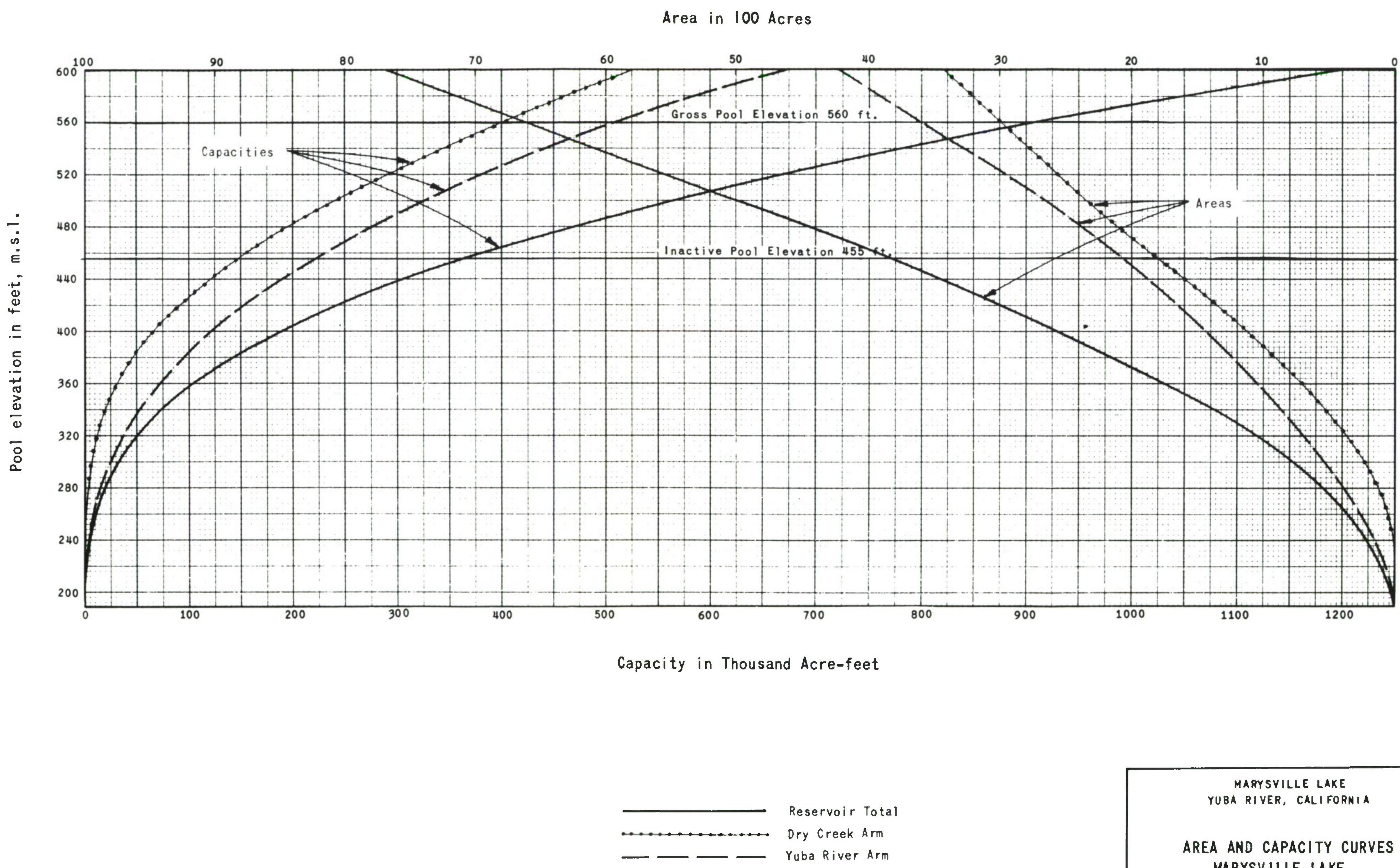
DONALD M. O'SHEI

SCALE: AS SHOWN
FILE NO. YU-4-20-40
SHEETS 40/1 TO 40/12
SHEET NO. 40/12

TO ACCOMPANY DESIGN MEMORANDUM NO. 3
GENERAL DESIGN MEMORANDUM, PHASE I, PLAN FORMULATION

APPENDIX L

PLATE XII



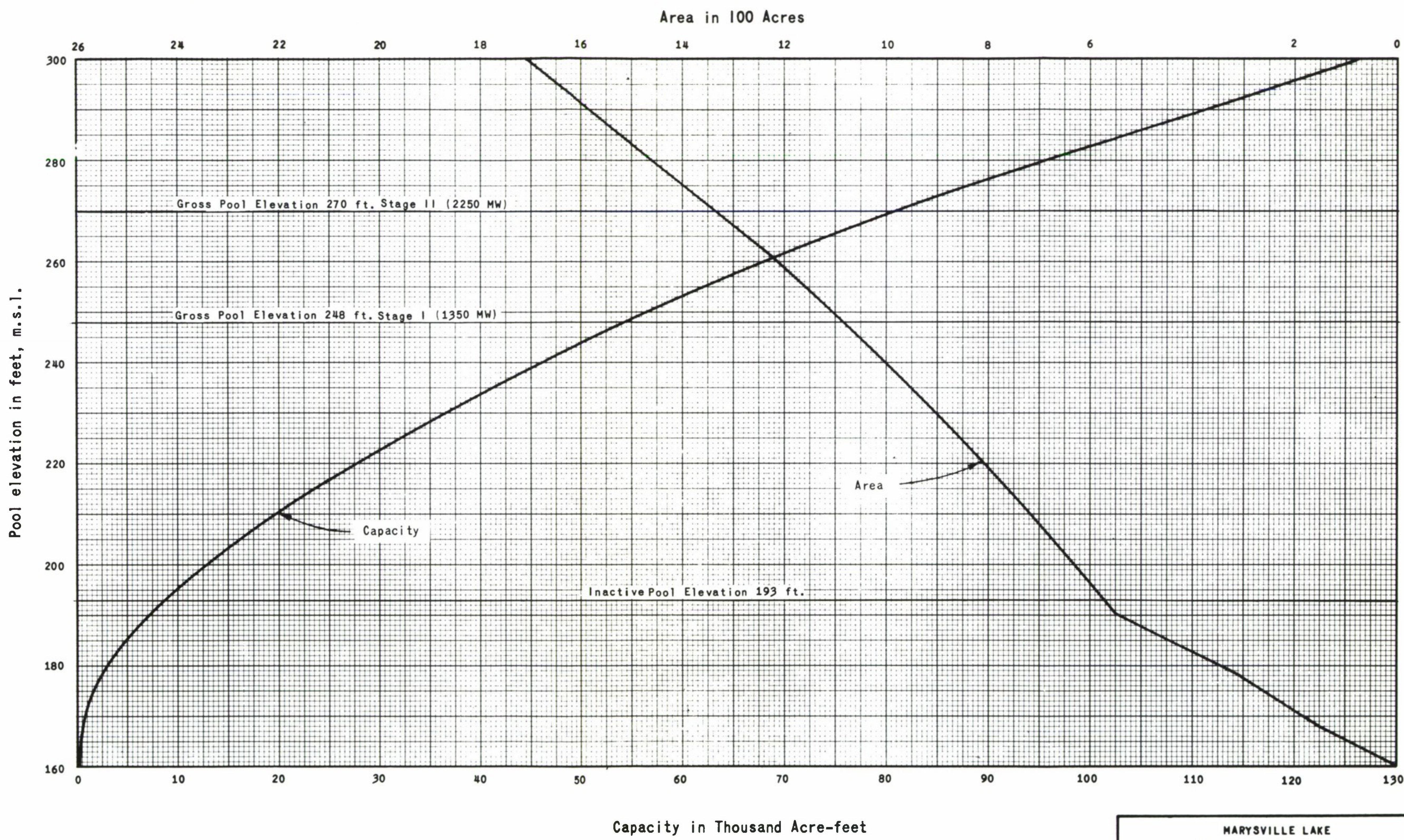
MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

AREA AND CAPACITY CURVES
MARYSVILLE LAKE

CORPS OF ENGINEERS SACRAMENTO, CALIFORNIA

Prepared: K.L.
Drawn: M.S.
Date: 3 JANUARY 1977

FIGURE L-I



MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA

AREA AND CAPACITY CURVES
AFTERBAY

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: K.L.
Drawn: M.S.
Date: 3 JANUARY 1977

FIGURE L-2

MARYSVILLE LAKE

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX M
DETAILED COST ESTIMATES

APPENDIX M - DETAILED COST ESTIMATES

Table of Contents

Tables

APPENDIX M - DETAILED COST ESTIMATES

1. Basis of estimate of first cost. -

The detailed estimate of first cost is given in Tables IV, VIII, and XII and is based on 1 October 1976 price levels. The cost for lands and damages was furnished by the District's Real Estate Division. The costs for the construction items were derived in the following manner:

- Unit prices used for the dams and related cost account features were developed by the District Estimating Section; whenever possible these costs were checked against historical cost data received on previous jobs that were similar in size and scope.

- The costs used for the major mechanical and electrical items are based on quotations received from reliable manufacturing companies for the specialty items. Installation costs for these items were determined in terms of cost per pound, as experienced on previous jobs performed in the Sacramento District. Average unit prices received on previous jobs performed by Sacramento District, other Corps Districts,and other Federal and State agencies were used for the remaining mechanical and electrical items.

- In general the lump sum and unit prices used for the powerhouse, mechanical, and electrical items in the powerhouse cost account feature were based on the NPD hydroelectric powerhouse cost analysis program.

The cost for the switchyard was based on data received from the Bonneville Power Administration; adjustments were made to their cost data to fit job conditions,

- The unit prices and lump sum costs used for the fish and wildlife facilities were based in part on the cost of the Dworshak and Nimbus Fish Hatcheries, adjusted to fit site conditions and functional requirements for the Marysville Lake project.

- Unit prices used for the remaining construction items, relocations, clearing, recreation facilities, etc. are based primarily on adjustment of average bid prices received for similar performed work by the Sacramento District, other Corps Districts,and the U.S. Bureau of Reclamation. Since foundation exploration work and concrete aggregate sources have not been positively defined and testing has not been completed, a 20 percent contingencies allowance is included in the estimate. This contingency allowance provides for the possibility of having to change the embankment slopes on the earthfill dams if poor soil and foundation conditions are encountered. It also allows for the possibility of encountering poor foundation rock under the concrete dam section and the possibility of having to import the sand for the mass concrete work.

- The amount used for Engineering and Design and Supervision and Administration was determined on the basis of costs incurred to date and those estimated to be required to complete the project.

2. Comparison of cost estimates. -

A comparison between the current and previous estimates is given in the following tabulation:

Item	Present Approved Estimate PB-3 (1976 Base)	Current Estimate GDM Phase I (1976 Base)
	(Thousand Dollars)	
FEDERAL		
Lands and Damages	72,700	39,200
Relocations	16,500	22,100
Reservoirs	6,660	7,160
Dams	370,670	531,300
Fish and Wildlife Facilities	9,050	15,500
Power Plant	156,570	227,500
Roads	730	1,670
Recreation Facilities	4,320	1,000
Cultural Resources & Preservation	-	9,570
Buildings, Grounds & Utilities	790	2,100
P.O. Equipment	610	1,000
Engineering & Design	33,900	49,400
Supervision & Administration	35,500	53,500
TOTAL FEDERAL COST (Stage I)	708,000	961,000

3. Explanation of changes in first cost. -

Changes between the current GDM Phase I estimate and the present approved estimate (15 April 1976 PB-3) are summarized as follows:

Lands and Damages: The net decrease of-$33,500,000 is due primarily to (1) the powerplant acquisition costs used in the estimate are based on the year 1986, therefore, no price level increase should have been applied to this item in the previous estimate (-$4,430,000); (2) a reevaluation by the District Real Estate Division determined that the fair market value for the YCWA Narrows II Powerplant should be $16,500,000 in lieu of $50,000,000 used in the previous estimate (-$33,500,000); and (3) the net decrease in cost is partly offset by an increase in the total lands required for the project and higher land costs based on a more detailed appraisal made by the District Real Estate Division(+$4,430,000).

Net decrease to Lands and Damages -$33,500,000

Relocations: The net increase of +$5,600,000 is due primarily to (1) the increase in quantities for State Highway 20 and Peoria Road due to lengthening of these roads by approximately 2.5 miles (+$4,160,000); (2) adding the cost for the Pleasant Valley Road, South Fork Bridge and also including an allowance for demolishing and removal of the existing South Fork Bridge (+$1,300,000); and (3) adding the cost for relocating a 24-acre dump to Beale Air Force Base (+$140,000).

Net increase to Relocations +$5,600,000

Reservoirs: The net increase of +$500,000 is due primarily to the increase in the land area requirement resulting when the reservoir capacity was increased from 890,000 acre-feet to 916,000 acre-feet with subsequent increase in the cost of boundary surveys and markers.

Net increase to Reservoir	+$500,000

Dams:

Yuba River Dam:

Main Dam: The net increase of +$47,270,000 is primarily due to increasing the reservoir capacity from 890,000 acre-feet to 916,000 acre-feet (which increased the height of the dam by 11 feet) flattening the embankment slopes based on an evaluation of current seismicity data, increasing the power capacity from 750 MW to 1,350 MW and including provisions for future expansion of the powerplant capacity from 1,350 MW to 2,250 MW. The major items affected by the changes are (1) increasing the foundation excavation quantities due to the powerplant capacity change (+$19,100,000); (2) increasing the embankment quantities due to the reservoir capacity change and due to evaluation of current seismicity data (+$14,210,000); (3) increasing the drilling and grouting quantities (+$10,940,000); and (4) repricing based on a more detailed quantity cost estimate breakdown (+$9,790,000) partially offset by a reduction in cost of the mechanical and electrical items when the number of radial gates with

operating machinery was reduced from 9 sets to 6 sets (-$6,770,000).

Net increase to Main Dam (+$47,270,000)

Power Intake Works: The net increase of +$30,030,000 is primarily due to changing the powerplant size from 750 MW to 1,350 MW and due to including provisions for future expansion of the powerplant size from 1,350 MW to 2,250 MW. Major items affected were (1) increase in the size of the temperature control towers (+$6,830,000); (2) increase in quantities in the trashracks, shutters, and steel liner plates (+$6,750,000); (3) increase in the cost of the mechanical and electrical items resulting when the size of the bulkhead gates and penstock gates was increased by approximately 50% (+$11,950,000); and (4) repricing based on a more detailed quantity cost estimate breakdown (+$4,500,000).

Net increase to Power Intake Works (+$30,030,000)

Net increase to Yuba River Dam +$77,300,000

Dry Creek Dam:

Dam and Dikes: The net increase of +$28,540,000 is primarily due to raising the height of the dam by approximately 12,5 feet; and flattening the embankment slopes; major items affected by the changes were (1) increase in quantities for foundation excavation and embankment (+$22,570,000); (2) adding items for foundation drilling and grouting (+$8,500,000); and (3) increase in repricing based on a more

detailed quantity cost estimate breakdown (+$9,000,000); partially offset when the excavation for the connecting channel between Dry Creek Reservoir and Yuba River Reservoir was reduced by approximately 3,500,000 cy (-$11,530,000).

Net increase to Dry Creek Dam and Dikes	(+$28,540,000)

Outlet Works: The net increase of +$1,540,000 reflects the change in quantities due to lengthening the conduit, resulting when the height of the dam was increased and the embankment slopes flattened.

Net increase to Outlet Works	(+$1,540,000)
Net increase to Dry Creek Dam and Dikes	+$30,080,000

Afterbay Dam:

Dam and Appurtenances: The net increase of +$53,250,000 is primarily due to increasing the height of the dam by 13 feet, adding facilities for a 15 MW powerplant, including provisions for future expansion of the main powerplant from 1,350 MW to 2,250 MW and reanalysis of seismicity data. The major items affected by the changes are (1) increasing the foundation excavation and embankment material quantities (+$32,770,000); (2) adding an item for foundation drilling and grouting (+$2,160,000); (3) increase in concrete quantities (+$6,290,000); (4) increase in the mechanical and electrical costs which reflects the increase in the tainter gates size from 42' x 25' to 53.5' x 59' and inclusion of other items to provide facilities for the 15 MW

powerplant (+$8,340,000); and (5) repricing based on a more detailed quantity cost estimate breakdown (+$3,690,000).

Net increase to Afterbay Dam	+$53,250,000
Net increase to Dams	+$160,630,000

<u>Fish and Wildlife Facilities</u>: The net increase of +$6,450,000 is primarily due to (1) an increase in the fish hatchery size in order to provide additional facilities for fish enhancement and due to increasing the size of the supplementary spawning channels (+$5,500,000); and (2) due to adding wildlife and waterfowl habitat and inclusion of a wildlife monitoring program (+$950,000).

Net increase to Fish and Wildlife Facilities	+$6,450,000

<u>Powerplants:</u>

<u>Powerplant (Yuba River Dam)</u>: The net increase of $58,630,000 is due primarily to increasing the size of the powerplant from 750 MWto 1,350 MW and due to including facilities for future enlargement of the powerplant capacity to 2,250 MW.

Net increase to Yuba River Dam Powerplant	(+$58,630,000)

<u>Powerplant (Afterbay Dam</u> The net increase of +$12,300,000 is due primarily to adding a 15 MW powerplant to the afterbay dam.

Net increase to Afterbay Dam Powerplant	(+$12,300,000)
Net increase to Powerplant Facilities	+$70,930,000

Roads: The net increase of +$940,000 is due primarily to increasing the length of the access roads by approximately 1.1 miles and adding resurfacing to a mile of existing access road.

Net increase to Roads	+$940,000

Recreation Facilities: The net decrease of -$3,320,000 is due primarily to decrease in scope of recreation facilities at the lake area from a medium plan to a minimum plan (-$3,660,000); partially offset by adding recreation facilities to the Lower Yuba Corridor (+$340,000).

Net decrease to Recreation Facilities	-$3,320,000

Cultural Resources and Preservation: The net increase of +$9,570,000 is due to adding an item for cultural resources and preservation.

Net increase to Cultural Resources and Preservation	+$9,570,000

Buildings, Grounds and Utilities: The net increase of +$1,310,000 is based on a reanalysis of project conditions and reflects the increase in project functional requirements.

Net increase to Buildings,Grounds and Utilities	+$1,310,000

Permanent Operating Equipment: The net increase of +$390,000 is due primarily to reanalysis of requirements.

Net increase to Permanent Operating Equipment	+$390,000

Engineering Design, Supervision and Administration: The net increase of +$33,500,000 was determined on the basis of costs incurred to date and estimated requirements to complete the project.

Net increase to Engineering, Design, Supervision and Administration	+$33,500,000
Net increase to Total Project Cost (Stage I)	+253,000,000

4. Basis of estimate of annual cost. -

The detailed estimate of annual costs is based on 1 October 1976 price levels. The estimate is based on the following:

- 3-1/4 and 6-3/8 percent interest rates and 100-year amortization period.

- Annual charges, including an adjustment for net loss of productivity of lands to be acquired for the project, were determined in accordance with EM 1120-2-104.

- Maintenance, operation, and replacement costs for the dams and reservoirs were computed from a Sacramento District compilation of cost factors, generally in terms of cost per acre-foot of reservoir capacity, percent of first cost of appurtenant items involved, and based on capacity curves for the powerplant and switchyard. Such factors are compiled from cost experience in the Sacramento District and elsewhere.

- Maintenance and operation costs for recreation facilities are estimated on a recreation-day use basis.

- Maintenance and operation costs for anadromous fishery mitigation, whildlife mitigation, and anadromous fishery enhancement are based on adjustment of amounts spent by the State of California at Nimbus Fish Hatchery and estimated costs for the Dworshak Dam Hatchery.

- The amount used for major replacements was determined by applying interest and amortization to the present worth of estimated replacement costs (including Engineering and Design, and Supervision and Administration).

5. Comparison of annual cost estimates. -

A comparison between the current and previous annual cost estimates is given in the following tabulation:

Item	Present approved estimate PB-3 (1976 Base) 3-1/4%	Current estimate GDM Phase I (1976 Base) 3-1/4%	Current Estimate GDM Phase I (1976 Base) 6-3/8%
Interest and amortization	26,715,600	35,521,500	72,267,500
Adjustment for net loss in productivity of lands	196,700	238,000	neg.
Operation, maintenance and replacement	3,529,300	8,514,500	7,881,500
Total Annual Cost (Federal)	$30,441,600	$44,274,000	$80,149,000

6. Explanation of changes of annual costs in the current estimate (GDM Phase 1 3-1/4%) from the present approved estimate. -

The difference of $13,832,400 is due primarily to increase in the first cost reflecting project design changes.

7. Explanation of changes in annual costs. -

Explanation of changes of annual costs in the current estimate (GDM Phase 1, 6-3/8%) from the present approved estimate. - The difference of $49,707,400 is due primarily to the increase in the first costs reflecting project design changes, and changing the interest rate from 3-1/4 to 6-3/8 percent.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
GDM PHASE I

TABLE I - ESTIMATE OF ANNUAL COST, STAGE I - 1,350 MW POWERPLANT
3-1/4% INTEREST
(1 October 1976 Price Level)

DAM AND RESERVOIR - FEDERAL

1. INVESTMENT COST

a.	First cost	$961,000,000
b.	Market value of Federal lands to be transferred to project	1,500,000
c.	Interest during construction	85,969,000
	(1) Yuba River Dam & Powerplant (7 yrs x 3-1/4% x 1/2 x 572,000,000 x 1.125)	(73,198,000)
	(2) Dry Creek Dam (5 yrs x 3-1/4% x 1/2 x 100,300,000 x 1.125)	(9,168,000)
	(3) Afterbay Dam & Powerplant (3 yrs x 3-1/4% x 1/2 x 65,700,000 x 1.125)	(3,603,000)
d.	Gross (or net) investment	$1,048,469,000

2. ANNUAL COST

a.	Interest (3-1/4% x 1d)	34,074,500
b.	Adjustment for loss of productivity of lands (0.0175 x 13,590,000)	238,000
c.	Amortization (100 yrs @ 0.00138 x 1d)	1,447,000
d.	Maintenance and operation Dam & Reservoir	7,412,500 (a)
e.	Major replacements Dam & Reservoir	1,102,000

3. TOTAL ANNUAL COST (FEDERAL) 44.274,000

(a) Includes annual payment for loss of tax revenue to Yuba and Nevada Counties in the amount of $16,000.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
GDM PHASE I

TABLE II - ESTIMATE OF ANNUAL COST, STAGE I - 1,350 MW POWERPLANT

6-3/8% INTEREST
(1 October 1976 Price Level)

DAM AND RESERVOIR - FEDERAL

1. INVESTMENT COST

a. First cost	$961,000,000
b. Market value of Federal lands to be transferred to project	1,500,000
c. Interest during construction	168,632,000
(1) Yuba River Dam & Powerplant (7 yrs x 6-3/8% x 1/2 x 572,000,000 x 1.125)	(143,581,000)
(2) Dry Creek Dam (5 yrs x 6-3/8% x 1/2 x 100,300,000 x 1.125)	(17,983,000)
(3) Afterbay Dam & Powerplant (3 yrs x 6-3/8% x 1/2 x 65,700,000 x 1.125)	(7,068,000)
d. Gross (or net) investment	1,131,132,000

2. ANNUAL COST

a. Interest (6-3/8% x 1d)	72,109,500
b. Adjustment for loss of productivity of lands	Neg
c. Amortization (100 yrs @ 0.00014 x 1d)	158,000
d. Maintenance and operation Dam & Reservoir	7,288,500 (a)
e. Major replacements Dam & Reservoir	593,000

3. TOTAL ANNUAL COST (FEDERAL) 80,149,000

(a) Includes annual payment for loss of tax revenue to Yuba and Nevada Counties in the amount of $16,000.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
GDM PHASE I
TABLE III - SUMMARY ESTIMATE OF FIRST COST, STAGE I - 1,350 MW POWERPLANT

(1 October 1976 Price Level)

Cost Acct. No.	Feature	Subtotal $	Total $
	FEDERAL DAM & RESERVOIR		
01.	LANDS AND DAMAGES		39,200,000(c)
02.	RELOCATIONS		22,100,000
	Roads & bridges	21,400,000	
	Cemeteries & utilities	700,000	
03.	RESERVOIRS		7,160,000
04.	DAMS		531,300,000
	Yuba River Dam	290,900,000	
	Power intake works	65,900,000	
	Dry Creek Dam & dikes	95,900,000	
	Outlet works	4,400,000	
	Afterbay Dam	74,200,000	
06.	FISH AND WILDLIFE FACILITIES		15,500,000
07.	POWERPLANT		227,500,000
	Powerplant Yuba River Dam	215,200,000	
	Powerplant Afterbay Dam	12,300,000	
08.	ROADS		1,670,000
14.	RECREATION FACILITIES (Initial)		1,000,000
18.	CULTURAL RESOURCES PRESERVATION		9,570,000
19.	BLDGS. GRDS. & UTILITIES		2,100,000
20.	P.O. EQUIPMENT		1,000,000
	SUBTOTAL		858,100,000
30.	ENGINEERING AND DESIGN		49,400,000
31.	SUPERVISION AND ADMINISTRATION		53,500,000 (a)
	TOTAL COST FEDERAL		961,000,000 (b)(c)

(a) Excludes GSA-controlled bldg. space cost.
(b) Excludes future recreation costs.
(c) Excludes cost of Federal land to be transferred to the project. Estimated market value is $1,500,000.

MARYSVILLE LAKE
YUBA RIVER, CALIFORNIA
GDM - PHASE I
PLAN FORMULATION

TABLE IV - ESTIMATE OF PROJECT FIRST COST, STAGE I - 1,350 MW POWERPLANT

(1 October 1976 Price Level)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
01.	LANDS AND DAMAGES				
	Lands				
	Project lands owned in fee above Englebright only	1,770	Ac.		(a)
	Project lands owned in fee	83	Ac.		(a)
	Private lands with Federal flowage easement	1,556	Ac.	365	567,940
	Lands required for project - 300 ft. minimum	11,687	Ac.	460	5,376,020
	Lands required for relocations	253	Ac.	430	108,790
	Mitigation lands	1,448	Ac.	540	781,920
	Additional mitigation lands, Area 1 (not at project site)	3,000	Ac.	500	1,500,000
	Lands locked (inaccessible)	885	Ac.	385	340,725
	Recreation lands - (Optimum level lake plan)	1,342	Ac.	395	530,090
	Recreation lands - Optimum level lake plan)	687	Ac.	610	419,070
	Government-owned lands	2620	Ac.		(a)
	Lower Yuba River (Fee)	1,683	Ac.	395	664,785
	Recreation sites	36	Ac.	.680	24,480
	Recreation site access:				
	Medium level plan (A-1)	5	Ac.	3,670	18,350
	Optimum level plan (A-2)	2	Ac.	1,830	3,660
	Access for sites R-2 thru R-7	67	Ac.	445	29,815
	Improvements - Bldg's etc.				2,176,200
	Mineral rights				150,000
	Damages				1,204,400
	Subtotal				13,896,245
	Contingencies				2,703,755
	Subtotal				16,600,000

(a) Excludes costs for Federal owned lands to be transferred to the project estimated market value at approximately $1,500,000.

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
01.	LANDS AND DAMAGES (Cont'd)				
	Lands (Cont'd)				
	Relocation costs				946,000
	Acquisition costs				934,000
	Major improvements				
	PG&E Narrows I Powerplant	1	Job	L.S.	3,470,000
	Y.C.W.A. Narrows II Powerplant	1	Job	L.S.	16,500,000
	New Colgate Powerplant tailwater depression system	1	Job	L.S.	750,000
	TOTAL LANDS AND DAMAGES				$39,200,000(a)
02.	RELOCATIONS				
.1	Roads & bridges				
	State Highway 20				
	Road - incl. suppl. work 40' paved (exc. 30,600 CY/Mi)	8.2	Mile	500,000	4,100,000
	Afterbay bridge (1650' x 40' with 2 - 120' piers)	66,000	S.F.	87	5,742,000
	Dry Creek Bridge (900' x 40' with 1 - 40' & 1 - 60' pier)	36,000	S.F.	76.50	2,754,000
	Demolish & remove existing conc. arch bridge (720'x22')	1	Job	L.S.	170,000
	Subtotal				12,766,000
	Contingencies, 20% ±				2,534,000
	Total				15,300,000
	County roads				
	Peoria Road				
	Road - incl. suppl. work 28' paved (exc. 8,300 CY/Mi)	2.8	Mile	190,000	532,000
	U.C. Field Station road				
	Road - incl. suppl. work 28' paved (exc. 32,100 CY/Mi)	6.7	Mile	320,000	2,144,000

(a) Excludes costs for Federal owned lands to be transferred to the project estimated market value at approximately $1,500,000.

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
02.	RELOCATIONS (Cont'd)				
.1	Roads & bridges (Cont'd)				
	Dry Creek Bridge (500' x 36' with 2- 36' piers)	18,000	S.F.	74.50	1,341,000
	Pleasant Valley Road				
	Road - incl. suppl. work 28' paved (embankment 73,200 CY/Mi)	0.5	Mile	450,000	225,000
	South Yuba River Bridge (330' x 32' with 2 - 35' piers)	10,560	S.F.	72	760,320
	Demolish & remove existing bridge	1	Job	L.S.	100,000
	Subtotal				5,102,320
	Contingencies, 20% ±				997,680
	Total				6,100,000
	Total Roads & Bridges				21,400,000
.7	Cemeteries & utilities				
	Pacific Gas & Electric Co.				
	Abandon & relocate				
	12KV - 1Ø single wood pole	1.2	Mile	8,200	9,840
	12KV - 3Ø single wood pole	5.9	Mile	9,000	53,100
	60KV with 12KV - 3Ø underbuilt twin wood pole	2.3	Mile	25,500	58,650
	Raised lines				
	60KV with 12KV - 3Ø underbuilt single wood pole	0.2	Mile	8,000	1,600
	60KV single wood pole	0.2	Mile	6,000	1,200
	Abandon & remove lines				
	12KV - 1Ø single wood pole	6.5	Mile	2,500	16,250
	12KV - 3Ø single wood pole	6.8	Mile	4,900	33,320
	60KV with 12KV - 3Ø underbuilt twin wood pole	3.0	Mile	8,200	24,600
	60KV single wood pole	6.3	Mile	6,500	40,950

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
02.	RELOCATIONS (Cont'd)				
.7	Cemeteries & utilities (Cont'd)				
	Less depreciation & salvage	1	Job	L.S.	-15,000
	Plus: Removal costs	1	Job	L.S.	2,000
	Subtotal				226,510
	Congingencies, 20% ±				43,490
	Total PG&E				270,000
	Pacific Telephone				
	Abandon & relocate				
	Lines to be relocated underground	0.7	Mile	30,000	21,000
	Lines to be relocated overhead	4.8	Mile	20,000	96,000
	Abandon & remove lines	7.1	Mile	3,500	24,850
	Less: Salvage				- 2,000
	Subtotal				139,850
	Contingencies, 20% ±				30,150
	Total Pacific Telephone				170,000
	Misc. Relocation				
	Farm ditch - relocate concrete structure & 18" RCP 700 L.F.	1	Job	L.S.	40,000
	Relocate 24 acre dump to Beale Air Force Base	1	Job	L.S.	115,000
	Subtotal				155,000
	Contingencies, 20% ±				30,000
	Total Misc. Relocation				185,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
02.	RELOCATIONS (Cont'd)				
.7	Cemeteries & utilities (Cont'd)				
	Cemetery relocation				
	Remove & relocate graves	100	Ea.	625	62,500
	Contingencies, 20% ±				12,500
	Total Cemeteries				75,000
	Total Cemeteries & Utilities				700,000
	TOTAL RELOCATIONS				$22,100,000
03.	RESERVOIRS				
	Clearing lake & afterbay	5,000	Ac.	270	1,350,000
	Removing fences, buildings, bridges, etc.	1	Job	L.S.	150,000
	Remove Englebright Dam to below minimum pool	173,300	C.Y.	16.50	2,859,450
	Fencing - 5-strand barbed wire	76	Mile	9,240	702,240
	Subtotal				5,061,690
	Contingencies, 20% ±				1,008,310
	Total				6,070,000
	Boundary survey & markings				1,090,000
	TOTAL RESERVOIRS				$ 7,160,000
04.	DAMS				
	Main dam (Yuba River Dam)				
	Clearing:				
	Damsite found. areas	120	Ac.	870	104,400
	Borrow areas	920	Ac.	165	151,800
	Diversion and care of water:				
	Cutoff trench (Slurry trench)				
	Upstream	56,300	S.F.	10.35	582,705
	Downstream	72,800	S.F.	10.35	753,480

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Main Dam (Yuba River Dam) cont'd				
	Cofferdam				
	Upstream	109,700	C.Y.	1.60	175,520
	Downstream	46,600	C.Y.	1.60	74,560
	Dewatering during construction	1	Job	L.S.	1,100,000
	Diversion conduits, etc.	1	Job	L.S.	275,000
	Excavation and foundation work:				
	Excavation				
	Foundation strip				
	a. To Zone 4 & 5	1,970,000	C.Y.	1.10	2,167,000
	b. To waste	282,500	C.Y.	1.15	324,875
	Embankment core trench				
	a. To Zone 4	596,000	C.Y.	4.85	2,890,600
	b. To waste	66,000	C.Y.	4.90	323,400
	Gravity section abutment exc.				
	a. To Zone 4	1,309,000	C.Y.	1.35	1,767,150
	b. To waste	68,600	C.Y.	1.40	96,040
	River channel exc.				
	a. To Zone 2	313,100	C.Y.	1.30	407,030
	b. To waste	16,500	C.Y.	1.40	23,100
	Gravity section rock exc.				
	a. To Zone 1 & 6	983,900	C.Y.	6.40	6,296,960
	b. To waste	51,800	C.Y.	6.50	336,700
	Foundation work:				
	Line drilling-presplit	113,900	S.F.	1.20	136,680
	Foundation drilling & grouting				
	Embankment section	287,200	L.F.	16.50	4,738,800
	Concrete section	56,000	L.F.	16.50	924,000
	Access gallery	96,000	L.F.	20.00	1,920,000
	Drilling drain holes	72,000	L.F.	13.10	943,200
	Foundation prep. & cleanup	79,100	S.Y.	15.00	1,186,500
	Dental fill-concrete	7,900	C.Y.	55.00	434,500
	Cement	23,700	CWT	3.00	71,100
	Earthen abutments				
	Excavation, borrow:				
	Strip and waste	503,200	C.Y.	0.80	402,560
	Impervious Zone 5	93,300	C.Y.	1.90	177,270
	Drain fill (processed)				
	Zone 3	403,200	C.Y.	5.20	2,096,640
	Dredge tailing Zone 2	7,552,300	C.Y.	1.30	9,817,990

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Main Dam (Yuba River Dam) cont'd				
	Embankment fill:				
	Impervious Zone 5	1,069,000	C.Y.	0.75	801,750
	Drain fill (processed) Zone 3	383,000	C.Y.	0.42	160,860
	Dredge tailings Zone 2	8,131,000	C.Y.	0.37	3,008,470
	Riprap Zone 6	231,000	C.Y.	0.60	138,600
	Quarry rock Zone 1	133,000	C.Y.	0.70	93,100
	Transition Zone 4	1,284,000	C.Y.	0.74	950,160
	Earthen abutments				
	Soil mechanics instruments	1	Job	L.S.	340,000
	Road surfacing, guard rails, and lighting	4,793	L.F.	20.00	95,860
	Beautification, landscaping, water quality control and environmental considerations	1	Job	L.S.	1,340,000
	Subtotal Foundation Work and Main Dam, Earthen Portion				47,628,360
	Non-overflow concrete section				
	Gravity monoliths:				
	Concrete	2,910,500	C.Y.	27.00	78,583,500
	Cement	5,821,000	CWT	3.00	17,463,000
	Pozzolan	101,900	Ton	55.00	5,604,500
	Water stops	12,010	L.F.	8.70	104,487
	Joint filler	12,010	L.F.	3.25	39,033
	Roadway (2,014'):				
	Concrete	1,230	C.Y.	102.00	125,460
	Cement	7,725	CWT	3.00	23,175
	Steel reinforcement	184,500	Lbs.	0.30	55,350
	Elevator tower:				
	Concrete	800	C.Y.	122.00	97,600
	Cement	5,000	CWT	3.00	15,000
	Steel reinforcement	120,000	Lbs.	0.30	36,000
	Handrailing	4,808	L.F.	20.00	96,160
	Overflow concrete section				
	Concrete monoliths:				
	Concrete	539,500	C.Y.	32.00	17,264,000
	Cement	1,079,000	CWT	3.00	3,237,000
	Pozzolan	18,900	Ton	55.00	1,039,500
	Water stops	2,290	L.F.	8.70	19,923
	Joint filler	2,290	L.F.	3.25	7,443

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Overflow concrete section (Cont'd)				
	Piers and walls:				
	Concrete	34,500	C.Y.	77.00	2,656,500
	Cement	177,700	CWT	3.00	533,100
	Steel Reinforcement	3,174,000	Lbs.	0.30	952,200
	Apron, stilling basin slabs, and deflectors:				
	Concrete	35,350	C.Y.	47.00	1,661,450
	Cement	157,000	CWT	3.00	471,000
	Steel reinforcement	2,475,000	Lbs.	0.30	742,500
	Drainage	1	Job	L.S.	200,000
	Drilling and grouting anchor/bars	21,100	L.F.	9.25	195,175
	Spillway bridge:				
	Concrete	1,050	C.Y.	197.00	206,850
	Cement	6,590	CWT	3.00	19,770
	Steel reinforcement	157,600	Lbs.	0.30	47,280
	A-36 steel	1,062,900	Lbs.	1.05	1,116,045
	Structure instrumentation	1	Job	L.S.	920,000
	Beautification, landscaping, water quality control & environmental considerations	1	Job	L.S.	4,000,000
	Subtotal Concrete section of Dam				137,533,001
	Gates and associated items				
	Spillway crest gates				
	Radial gates incl. anchorage (55' W x 57.5' H x 55' R x 55' Hd)	6	Set	1,750,000	10,500,000
	Operating machinery	6	Set	350,000	2,100,000
	River flow & irrigation outlets				
	Bulkhead shutters (11.5' W x 9.75' H - 10' Hd)	3	Ea.	50,000	150,000
	Shutter guides and frames (260')	3	Set	25,000	75,000
	Bulkhead gates (8.25' W x 9.33' H x 340' Hd)	1	Ea.	150,000	150,000
	Bulkhead gate guides and frames	3	Ea.	90,000	270,000
	Bypass piping	1	Job	L.S.	100,000
	Slide gates - double inline (3.5' W x 7.0'H x 340' Hd)	3	Set	450,000	1,350,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Gates and associated items (Cont'd)				
	Install slide gates (3 sets)	1	Job	L.S.	150,000
	Operating equipment (for slide gates)	1	Job	L.S.	125,000
	Air vent & bypass piping	1	Job	L.S.	200,000
	Subtotal Gates & Associated Items				15,170,000
	Subtotal Foundation Work and Main Dam, Earthen Portion				47,628,360
	Subtotal Concrete Section of Dam				137,533,001
	Subtotal				200,331,361
	Contingencies, 20% $\pm$				40,068,639
	Subtotal				240,400,000
	Escalation to midpoint of construction				50,500,000
	Total Main Dam (Yuba River Dam)				$290,900,000
	Power intake works				
	Temperature towers:				
	Concrete	65,800	C.Y.	122.00	8,027,600
	Cement	339,500	CWT	3.00	1,018,500
	Steel reinforcement	6,054,000	Lbs.	0.30	1,816,200
	Trashracks	1,898,000	Lbs.	1.50	2,847,000
	Shutters	1,436,000	Lbs.	1.75	2,513,000
	Mechanical				
	Turbines:				
	Intake stop logs (bulkhead) (36.0' W x 49.17' H x 340' Hd)	1	Set	4,000,000	4,000,000
	Intake stop log guides	5	Set	100,000	500,000
	Penstock gates (26' W x 39.17' H x 340' Hd)	3	Ea	3,000,000	9,000,000
	Penstock gate guides & frames	5	Set	100,000	500,000
	Penstock gate hoists & operating equipment	3	Set	1,000,000	3,000,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Power intake works (Cont'd)				
	Mechanical (Cont'd)				
	Intake vents	5	Set	40,000	200,000
	Bypass piping	5	Set	30,000	150,000
	Formed part of exterior of dam				
	Concrete	8,000	C.Y.	147.00	1,176,000
	Cement	41,300	CWT	3.00	123,900
	Steel reinforcement	1,200,000	Lbs.	0.30	360,000
	Structure instrumentation	1	Job	L.S.	20,000
	Hoisting equipment				
	Gantry crane (280 ton + 50 ton aux.)	1	Ea.	500,000	500,000
	Electrical work, interior and exterior	1	Job	L.S.	400,000
	Beautification, landscaping, water quality control & environmental considerations	1	Job	L.S.	540,000
	Subtotal Power Intake Works				36,692,200
	Associated General Items				
	Steel lining				
	A537 plate (penstocks)	7,095,000	Lbs.	1.05	7,449,750
	A36 stiffeners	211,700	Lbs.	1.65	349,305
	Passenger elevator	1	Job	L.S.	250,000
	Compressed air system	1	Job	L.S.	75,000
	Electrical	1	Job	L.S.	300,000
	Sump pumps and chain hoists	1	Job	L.S.	100,000
	Standby power generator	1	Job	L.S.	80,000
	Painting, testing, quality control & miscellaneous	1	Job	L.S.	100,000
	Subtotal Associated General Items				8,704,055
	Subtotal Power Intake Works				36,692,200
	Subtotal				45,396,255
	Contingencies, 20% ±				9,083,745
	Subtotal				54,480,000
	Escalation to midpoint of construction				11,420,000
	Total Power Intake Works				$65,900,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Dry Creek Dam & Dikes				
	Connecting channel:				
	Excavation, common				
	a. To Zone 4	926,500	C.Y.	1.70	1,575,050
	b. To waste	126,900	C.Y.	1.80	228,420
	Excavation rock:				
	a. To Zone 1 & 2	155,200	C.Y.	6.40	993,280
	b. To waste	17,300	C.Y.	6.50	112,450
	Dry Creek Dam				
	Excavation & foundation work:				
	Foundation strip:				
	a. To Zone 4 & 5	4,768,000	C.Y.	1.10	5,244,800
	b. To waste	130,500	C.Y.	1.15	150,075
	Embankment core trench				
	a. To Zone 4	402,600	C.Y.	4.85	1,952,610
	Foundation drilling & grouting	355,200	L.F.	16.50	5,860,800
	Excavation, borrow:				
	Strip and waste	1,278,500	C.Y.	0.80	1,022,800
	Impervious Zone 5	1,800,900	C.Y.	1.90	3,421,710
	Drain fill (processed) Zone 3	1,239,300	C.Y.	5.25	6,506,325
	Dredge tailings Zone 2	16,603,900	C.Y.	1.35	22,415,265
	Embankment fill:				
	Impervious Zone 5	3,766,700	C.Y.	0.63	2,373,021
	Transition Zone 4	4,807,300	C.Y.	0.74	3,557,402
	Drain fill (processed) Zone 3	1,177,300	C.Y.	0.42	494,466
	Quarry rock Zone 1	162,300	C.Y.	0.70	113,610
	Dredge tailings Zone 2	20,522,100	C.Y.	0.41	8,414,061
	Riprap Zone 6	236,200	C.Y.	0.60	141,720
	Soil mechanics instruments	1	Job	L.S.	920,000
	Road surfacing, guard rails and lighting	5,920	L.F.	20.00	118,400
	Beautification, landscaping water quality control and environmental consideration	1	Job	L.S.	1,970,000
	Subtotal Dry Creek Dam				67,586,265

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Dike B				
	Excavation and foundation work:				
	Foundation strip				
	a. To Zone 4 & 5	41,700	C.Y.	1.10	45,870
	b. To waste	4,900	C.Y.	1.15	5,635
	Embankment core trench				
	a. To Zone 4	14,200	C.Y.	4.85	68,870
	Foundation drilling & grouting	6,000	L.F.	16.50	99,000
	Excavation borrow:				
	Strip and waste	4,200	C.Y.	0.80	3,360
	Impervious Zone 5	24,700	C.Y.	2.00	49,400
	Drain fill (processed) Zone 3	11,400	C.Y.	5.35	60,990
	Embankment fill:				
	Impervious Zone 5	40,900	C.Y.	0.60	24,540
	Transition Zone 4	44,300	C.Y.	0.74	32,782
	Drain fill (processed) Zone 3	10,800	C.Y.	0.42	4,536
	Dredge tailings Zone 2	98,000	C.Y.	0.75	73,500
	Riprap Zone 6	7,800	C.Y.	0.70	5,460
	Quarry rock Zone 1	22,600	C.Y.	0.80	18,080
	Road surfacing, guard rails, etc.	885	L.F.	20.00	17,700
	Beautification, landscaping, water quality control and environmental consideration	1	Job	L.S.	15,000
	Subtotal Dike B				524,723
	Dike A				
	Excavation and foundation work:				
	Foundation strip				
	a. To Zone 4 & 5	167,100	C.Y.	1.10	183,810
	b. To waste	9,200	C.Y.	1.15	10,580
	Embankment core trench				
	a. To Zone 4	26,400	C.Y.	4.85	128,040
	Foundation drilling & grouting	11,000	L.F.	16.50	181,500

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Dike A (Cont'd)				
	Excavation, borrow:				
	Strip and waste	13,800	C.Y.	0.80	1,000,000
	Impervious Zone 5	27,900	C.Y.	2.05	57,195
	Drain fill (processed) Zone 3	49,100	C.Y.	5.40	265,140
	Embankment fill:				
	Impervious Zone 5	100,200	C.Y.	0.69	69,138
	Transition Zone 4	107,000	C.Y.	0.74	79,180
	Drain fill (processed) Zone 3	46,600	C.Y.	0.42	19,572
	Dredge tailings Zone 2	303,000	C.Y.	0.80	242,400
	Riprap Zone 6	19,000	C.Y.	0.75	14,250
	Quarry rock Zone 1	38,500	C.Y.	0.85	32,725
	Road surfacing, guard rails, etc.	1,260	L.F.	20.00	25,200
	Beautification, landscaping, water quality control and environmental consideration	1	Job	L.S.	40,000
	Subtotal Dike A				1,359,770
	Subtotal Dry Creek Dam				67,586,265
	Subtotal Dike B				524,723
	Subtotal				69,470,758
	Contingencies, 20% ±				13,889,242
	Total				83,360,000
	Escalation to midpoint of construction				12,540,000
	Total Dry Creek Dam and Dikes				$95,900,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Outlet works				
	Excavation and foundation work				
	Stripping	6,700	C.Y.	2.00	13,400
	Excavation:				
	Common	104,850	C.Y.	2.50	262,125
	Rock	22,100	C.Y.	10.00	221,000
	Line drilling and presplit	60,750	S.F.	1.20	72,900
	Intake structure				
	Concrete	58	C.Y.	102.00	5,916
	Cement	365	CWT	3.00	1,075
	Steel reinforcement	8,700	Lbs.	0.30	2,610
	Trashracks	5,200	Lbs.	1.50	7,800
	Conduit (4.5'Ø)				
	Concrete pipe	672	C.Y.	122.00	81,984
	Concrete pipe bedding	111	C.Y.	80.00	8,880
	Cement	4,705	CWT	3.00	14,115
	Steel reinforcement	100,800	Lbs.	0.30	30,240
	Gate chamber:				
	Concrete - mass	125	C.Y.	37.00	4,625
	Concrete	330	C.Y.	147.00	48,510
	Cement	2,600	CWT	3.00	7,800
	Steel reinforcement	49,500	Lbs.	0.30	14,850
	Structural Steel	1,700	Lbs.	1.70	2,890
	Access Gallery - "D" Section:				
	Concrete	4,015	C.Y.	102.00	409,530
	Cement	25,175	CWT	3.00	75,525
	Steel Reinforcement	602,250	Lbs.	0.30	180,675
	Conduit(3.5'Ø):				
	Pipe - A537 steel	82,950	Lbs.	1.10	91,245
	Stiffeners A36 steel	8,300	Lbs.	1.70	14,110
	Portal, stilling basin, and operations house:				
	Concrete - mass	133	C.Y.	37.00	4,921
	Concrete	615	C.Y.	102.00	62,730
	Cement	4,450	CWT	3.00	13,350
	Steel reinforcement	92,250	Lbs.	0.30	27,675
	Beautification, landscaping, water quality control & environmental consideration	1	Job	L.S.	50,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Outlet works (Cont'd)				
	Gates and associated items				
	Bulkhead gate				
	(4.5'W x 4.5'H x 319'Hd)	1	Ea.	100,000	100,000
	Gate guides and frames	1	Ea.	50,000	50,000
	Bypass piping (8" x 700')	1	Job	L.S.	100,000
	Slide gate - double inline				
	(4.0'W x 4.0'H x 325'Hd)	1	Set	350,000	350,000
	Install slide gates	1	Job	L.S.	50,000
	Gate operating equipment	1	Job	L.S.	75,000
	Air vent piping (33"Ø)	1	Job	L.S.	200,000
	Chain hoist & sump pump	1	Job	L.S.	100,000
	Standby power generator	1	Job	L.S.	80,000
	Electric power & lighting	1	Job	L.S.	250,000
	Ventilating system	1	Job	L.S.	75,000
	Miscellaneous metals	1	Job	L.S.	5,000
	Structure instrumentation	1	Job	L.S.	2,000
	Painting, testing, quality				
	Control and Miscellaneous	1	Job	L.S.	50,000
	Subtotal				3,217,501
	Contingencies 20%				642,499
	Subtotal				3,860,000
	Escalation to midpoint of construction				540,000
	Total Outlet Works				$ 4,400,000
	Afterbay dam				
	Clearing:				
	Damsite	20	Ac.	870.00	17,400
	Borrow areas	50	Ac.	165.00	8,250
	Diversion and care of water				
	Cutoff trench (ICOS trench)				
	Upstream	106,800	S.F.	15.00	1,602,000
	Downstream	106,800	S.F.	15.00	1,602,000
	Cofferdam				
	Upstream dredge tailings				
	Zone 2	190,000	C.Y.	1.55	294,500
	Upstream impervious Zone 5	13,500	C.Y.	2.15	29,025

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Afterbay dam (Cont'd)				
	Downstream Dredge Tailings Zone 2	150,000	C.Y.	1.55	232,500
	Downstream impervious Zone 5	13,500	C.Y.	2.15	29,025
	Dewatering during construction	1	Job	L.S.	4,230,000
	Excavation and foundation work:				
	Excavation				
	Foundation strip abutment				
	a. To Zone 4	80,000	C.Y.	1.10	88,000
	b. To waste	23,000	C.Y.	1.20	27,600
	Abutment core trench				
	a. To Zone 4	193,000	C.Y.	4.85	936,050
	b. To waste	10,000	C.Y.	4.95	49,500
	Spillway section abutment exc.				
	a. To Zone 5	287,000	C.Y.	1.10	315,700
	b. To waste	47,000	C.Y.	1.20	56,400
	Spillway section rock exc.				
	a. To Zone 2	603,000	C.Y.	6.40	3,859,200
	Foundation strip river channel				
	a. To Zone 2	175,000	C.Y.	1.10	192,500
	River channel core trench				
	a. To Zone 2	3,757,000	C.Y.	1.30	4,884,100
	b. To waste	703,000	C.Y.	1.45	1,019,350
	Diversion channel				
	a. To Zone 2 & 5	1,240,000	C.Y.	1.45	1,798,000
	b. To waste	65,000	C.Y.	1.55	100,750
	Foundation work:				
	Line drilling - presplit	87,800	S.F.	1.20	105,360
	Foundation drilling & grouting				
	Embankment section	100,000	L.F.	16.50	1,650,000
	Access gallery	6,300	L.F.	20.00	126,000
	Drilling drain holes	4,500	L.F.	13.10	58,950
	Foundation preparation	8,000	S.Y.	15.00	120,000
	Dental fill - concrete	800	C.Y.	55.00	44,000
	Cement	2,400	CWT	3.00	7,200
	Earthen abutments				
	Excavation, borrow:				
	Strip and waste	100,000	C.Y.	0.90	90,000
	Impervious Zone 5	263,000	C.Y.	1.75	460,250
	Dredge tailings Zone 2	1,631,000	C.Y.	1.20	1,957,200

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Afterbay dam (Cont'd)				
	Embankment fill:				
	Impervious Zone 5	831,000	C.Y.	0.68	565,080
	Drain fill (processed)Zone 3	485,000	C.Y.	0.42	203,700
	Dredge tailings Zone 2	6,025,000	C.Y.	0.57	3,434,250
	Riprap Zone 6	67,000	C.Y.	6.00	402,000
	Transition Zone 4	456,000	C.Y.	0.76	346,560
	Soil mechanics instruments	1	Job	L.S.	230,000
	Road surfacing, guard rails, and lighting	6,650	L.F.	20.00	133,000
	Beautification, landscaping, water quality control and environmental consideration	1	Job	L.S.	930,000
	Subtotal Afterbay, foundation work on earthen portion.				32,235,400
	Spillway				
	Concrete monoliths:				
	Concrete	89,330	C.Y.	32.00	2,858,560
	Cement	178,660	CWT	3.00	535,980
	Pozzolan	3,570	Ton	55.00	196,350
	Water stops	2,060	L.F.	8.70	17,922
	Joint filler	2,060	L.F.	3.25	6,695
	Piers, walls, baffles, & end sill				
	Concrete - formed	32,560	C.Y.	80.00	2,604,800
	Concrete - unformed	1,000	C.Y.	47.00	47,000
	Cement	173,170	CWT	3.00	519,510
	Steel reinforcement	4,027,200	Lbs.	0.30	1,208,160
	Stilling basin slab				
	Concrete	14,980	C.Y.	47.00	704,060
	Cement	66,510	CWT	3.00	199,530
	Steel reinforcement	1,048,600	Lbs.	0.30	314,580
	Upstream walls:				
	Concrete - formed	3,970	C.Y.	80.00	317,600
	Concrete - unformed	590	C.Y.	47.00	27,730
	Cement	23,530	CWT	3.00	70,590
	Steel reinforcement	547,200	Lbs.	0.30	164,160
	Spillway bridge: 33' wide 5 spans @ 61.5'				
	Concrete	280	C.Y.	197.00	55,160
	Cement	1,760	CWT	3.00	5,280
	Steel reinforcement	69,550	Lbs.	0.30	20,865
	A-36 steel	190,050	Lbs.	1.05	199,553

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Afterbay dam (Cont'd)				
	Backfill	13,000	C.Y.	3.25	42,250
	Foundation drains (stilling basin)	1	Job	L.S.	100,000
	Drilling and grouting				
	Anchor bars	30,300	L.F.	9.25	280,275
	Handrails	2,000	L.F.	20.00	40,000
	Structure instrumentation	1	Job	L.S.	40,000
	Beautification, landscaping, water quality control & environmental consideration	1	Job	L.S.	320,000
	Subtotal Afterbay Concrete Portion				10,896,610
	Gates & associated items				
	Tainter gates (53.5' W x 59' H)	5	Ea.	1,300,000	6,500,000
	Tainter gate hoists (incl. oper. equip.)	5	Ea.	500,000	2,500,000
	Stop logs (incl. lifting beams)	1	Set	500,000	500,000
	Top seal tainter gate (8.5' W x 15' H - 110' Hd)	1	Ea.	275,000	275,000
	Tainter gate hoists (incl. oper. equip.)	1	Ea.	75,000	75,000
	Bulkhead gate (8.5' W x 17' H - 110' Hd)	1	Ea.	110,000	110,000
	Bulkhead guides & miscellaneous	1	Ea.	85,000	85,000
	Electrical	1	Job	L.S.	500,000
	Painting and testing, etc.	1	Job	L.S.	100,000
	Subtotal Afterbay Gates, etc.				10,645,000
	Subtotal Earthern Portion of Dam				32,235,400
	Subtotal Concrete Portion of Dam				10,896,610
	Subtotal				53,777,010
	Contingencies, 20% ±				10,752,990
	Subtotal				64,530,000
	Escalation to midpoint of construction				9,670,000
	Total Afterbay				$74,200,000
	TOTAL DAMS				$531,300,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
06.	FISH AND WILDLIFE FACILITIES				
	Fish facilities:				
	Hatchery 50,000 salmon 10,000 steelhead	1	Job	L.S.	8,000,000
	Supplemental spawning channels				
	a. Channel excavation uncl.	2,825,000	C.Y.	1.20	3,390,000
	b. Embankment & fill	175,000	C.Y.	1.50	262,500
	Subtotal				11,652,500
	Contingencies, 20% ±				2,347,500
	Total Fish Facilities				14,000,000
	Wildlife facilities:				
	Spenceville Wildlife and Recreation Area - 1,500 A.F. of water/year, with pumphouse and distribution lines for Dumpsey Creek & Vineyard Creek	1	Job	L.S.	460,000
	Nesting habitat for wildfowl	1	Job	L.S.	25,000
	Spenceville, Vegetation improvement	1	Job	L.S.	100,000
	Hackett Creek, Habitat improvement	1	Job	L.S.	300,000
	Turkey mitigation lands, habitat improvement	1	Job	L.S.	65,000
	Government-owned gravel tailings, habitat improvement	1	Job	L.S.	150,000
	Detention Ponds and Habitat improvement	1	Job	L.S.	100,000
	Fish and wildlife monitoring and analysis program	1	Job	L.S.	50,000
	Subtotal				1,250,000
	Contingencies, 20% ±				250,000
	Total Wildlife Facilities				1,500,000
	TOTAL FISH AND WILDLIFE FACILITIES				$ 15,500,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT MAIN DAM (1,350MW)				
.1	Powerhouse				
	Excavation				
	Building:				
	Common	100,600	C.Y.	1.10	110,660
	Rock	301,400	C.Y.	5.50	1,657,700
	Close line drilling - presplit	56,400	S.F.	1.20	67,680
	Parking & building access:				
	Common	62,500	C.Y.	1.10	68,750
	Rock	51,600	C.Y.	5.50	283,800
	Close line drilling - presplit	48,900	S.F.	1.20	58,680
	Foundation preparation	9,000	S.Y.	6.50	58,500
	Backfill and grading	562,700	C.Y.	3.25	1,828,775
	Penstocks				
	A537 (Can)	5,657,000	Lbs.	1.05	5,939,850
	A36 (Stiffeners)	270,600	Lbs.	1.65	446,490
	Concrete	19,700	C.Y.	120.00	2,364,000
	Cement	101,700	CWT	3.00	305,100
	Steel reinforcement	2,955,000	Lbs.	0.30	886,500
	Building (170.5' x 472')	1	Job	L.S.	15,850,000
	Draft tube bulkheads	3	Ea.	290,000	870,000
	Draft tube gate guides std. turbines	1	Set	110,000	110,000
	Draft tube gate guides pump turbines	3	Set	120,000	360,000
	Miscellaneous metal	1	Job	L.S.	2,100,000
	Beautification, landscaping, water quality control & environmental considerations	1	Job	L.S.	800,000
	Subtotal				34,166,485
	Contingencies, 20% ±				6,833,515
	Subtotal				41,000,000
	Escalation to midpoint of construction				8,600,000
	Total Powerhouse				49,600,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT (Cont'd)				
.2	Turbines and generators				
	Standard turbine units:				
	Turbines	1	Ea.	10,350,000	10,350,000
	Governors	1	Ea.	190,000	190,000
	Generators	1	Ea.	6,980,000	6,980,000
	Pump turbine units:				
	Turbines	2	Ea.	12,950,000	25,900,000
	Governors	2	Ea.	190,000	380,000
	Motor generators	2	Ea.	6,310,000	12,620,000
	Butterfly valves & oper. 30' Ø - 372' Hd	2	Ea.	10,000,000	20,000,000
	Subtotal				76,420,000
	Contingencies, 20% ±				15,280,000
	Subtotal				91,700,000
	Escalation to midpoint of construction				19,200,000
	Total Turbines and Generators				110,900,000
.3	Switchyard accessory, miscellaneous, powerplant equipment, and tailrace switchyard equipment	1	Job	L.S.	16,000,000
	Mechanical items:				
	Powerhouse bridge crane	1	Job	L.S.	2,785,000
	Miscellaneous mechanical equipment & accessories	1	Job	L.S.	8,390,000
	Electrical items:				
	Power transformers	3	Ea.	785,000	2,355,000
	Miscellaneous electrical equipment & accessories	1	Job	L.S.	5,570,000
	Tailrace				
	Excavation:				
	Common	150,400	C.Y.	1.65	248,160
	Rock	254,800	C.Y.	5.50	1,401,400
	Close line drilling - presplit	56,700	S.F.	1.20	68,040
	Drilling and grouting for anchor bars	6,800	L.F.	9.25	62,900
	Concrete	4,200	C.Y.	120.00	504,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT (Cont'd)				
.3	Switchyard accessory, miscellaneous, powerplant equipment, and tailrace (Cont'd)				
	Cement	21,700	CWT	3.00	65,100
	Steel reinforcement	386,400	Lbs.	0.30	115,920
	Beautification, landscaping, water quality control, & environmental consideration	1	Job	L.S.	110,000
	Subtotal				37,675,520
	Contingencies, 20% ±				7,524,480
	Subtotal				45,200,000
	Escalation to midpoint of construction				9,500,000
	Total Switchyard Accessory, Misc. Equip. & Tailrace				54,700,000
	TOTAL POWERPLANT MAIN DAM				$ 215,200,000
07.A	AFTERBAY POWERPLANT (15MW)				
.1A	Powerhouse				
	Excavation				
	Common	3,756	C.Y.	1.10	4,132
	Rock	10,316	C.Y.	5.50	56,738
	Foundation preparation	1,595	S.Y.	6.50	10,368
	Powerhouse struct.				
	Concrete	18,957	C.Y.	230.00	4,360,110
	Powerhouse roof	1	Job	L.S.	35,000
	Backfill & grading	5,406	C.Y.	3.25	17,570
	Powerhouse intake works				
	Intake trashracks	1	Job	L.S.	20,000
	Intake trashrack guides	1	Job	L.S.	105,000
	Intake gate and bulkhead guides and sills	1	Job	L.S.	25,000
	Intake bulkhead	1	Job	L.S.	10,000
	Intake gate	1	Job	L.S.	20,000
	Intake gantry crane	1	Job	L.S.	260,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.A	AFTERBAY POWERPLANT (Cont'd)				
.1A	Powerhouse (Cont'd)				
	Draft tube equipment				
	Draft tube bulkhead				
	Guide and sills	1	Job	L.S.	60,000
	Draft tube bulkheads	1	Job	L.S.	20,000
	Subtotal				5,003,918
	Contingencies, 20% ±				996,082
	Subtotal				6,000,000
	Escalation to midpoint of construction				900,000
	Total Powerhouse				6,900,000
.2A	Turbines and generators				
	Turbines	2	Ea.	250,000	500,000
	Governors	2	Ea.	125,000	250,000
	Generators	2	Ea.	520,000	1,040,000
	Subtotal				1,790,000
	Contingencies, 20% ±				360,000
	Subtotal				2,150,000
	Escalation to midpoint of construction				300,000
	Total Turbines and Generators				2,450,000
.3A	Switchyard accessory and misc. powerplant equipment and tailrace				
	Mechanical items				
	Powerhouse crane	1	Job	L.S.	150,000
	Misc. mechanical equipment	1	Job	L.S.	370,000
	Electrical items				
	Transformers	2	Ea.	180,000	360,000
	Switchyard equipment	1	Job	L.S.	695,000
	Misc. electrical equipment	1	Job	L.S.	195,000
	Misc. powerplant cost	1	Job	L.S.	175,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.A	AFTERBAY POWERPLANT (Cont'd)				
.3A	Switchyard accessory and misc. powerplant equipment and tailrace				
	Tailrace				
	Excavation:				
	Common	49,140	C.Y.	1.10	54,054
	Rock	5,140	C.Y.	5.50	28,270
	Water quality control and environmental consid.	1	Job	L.S.	100,000
	Subtotal				2,127,324
	Contingencies, 20% ±				422,676
	Subtotal				2,550,000
	Escalation to midpoint of construction				400,000
	Total Switchyard Accessory and Misc. Equip. & Tailrace				2,950,000
	Total Powerplant Afterbay Dam				$ 12,300,000
	TOTAL POWERPLANT				$ 227,500,000
08.	ROADS				
	Access road - existing 20' paved road resurface & suppl. work	1.0	Mile	30,000	30,000
	Access road - Incl. suppl. work 28' paved (Exc. 32,000 CY/Mi)	5.1	Mile	260,000	1,326,000
	Beautification and landscaping	1	Job	L.S.	40,000
	Subtotal				1,396,000
	Contingencies, 20% ±				274,000
	TOTAL ROADS				$ 1,670,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
14.	RECREATION FACILITIES (INITIAL)				
	Recreation facilities around the lake				
	Road End Development				
	Road end turn-around paved (exc. 200 CY)	13	Ea.	4,600	59,800
	Parking area - 25 cars paved (1,500 SY)	13	Ea.	7,800	101,400
	Portable chemical toilets	26	Ea.	500	13,000
	Landscape development	1	Job	L.S.	35,800
	Subtotal Road End Development				210,000
	Englebright relocation - headquarters				
	Access road incl. suppl. work Double lane paved (exc. 70,000 CY/Mi)	0.2	Mile	405,000	81,000
	Boat launching ramp excavation	2,200	C.Y.	4	8,800
	Boat launching ramp 2-lanes 6" conc. with stab. aggr.	460	L.F.	100	46,000
	Boarding floats	2	Ea.	8,500	17,000
	Parking area 50 cars excavation	4,100	C.Y.	3	12,300
	Parking area 50 cars paved (3,000 SY)	1	Job	L.S.	12,000
	Boat launching ramp turnaround excavation	2,700	C.Y.	3	8,100
	Boat launching ramp turnaround paved (1,500 SY)	1	Job	L.S.	2,600
	Camp site boat-in (150 SY)	35	Ea.	700	24,500
	Subtotal Headquarters				212,300
	Englebright relocation-Joe Miller Ravine				
	Access road incl. suppl. work Double lane paved (exc. 70,000 CY/Mi)	0.1	Mile	405,000	40,500
	Boat launching ramp excavation	2,200	C.Y.	4	8,800
	Boat launching ramp 2-lanes 6" conc. with stab. aggr.	570	L.F.	100	57,000
	Boarding floats	2	Ea.	8,500	17,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
14.	RECREATION FACILITIES (INITIAL) (Cont'd)				
	Recreation facilities around the lake (Cont'd)				
	Boat launching ramp turnaround Excavation	600	C.Y.	3	1,800
	Boat launching ramp turnaround Paved (1,500 SY)	1	Job	L.S.	2,600
	Subtotal - Joe Miller Ravine				127,700
	Subtotal				550,000
	Contingencies, 20% ±				110,000
	Total Recreation Facilities Around the Lake				660,000
	Recreation facilities Lower Yuba River				
	River mouth area				
	Access road incl. suppl. work Two lanes unpaved (exc. 7,500 CY/Mi)	0.5	Mile	70,000	35,000
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Boat launching ramp unpaved Stab. aggr. (1,670 SY)	1	Job	L.S.	5,800
	Picnic site	4	Ea.	590	2.360
	Portable chemical toilets	2	Ea.	500	1,000
	Landscaping development	1	Job	L.S.	1,520
	Subtotal River Mouth Area				49,480
	Hallwood area				
	Access road incl. suppl. work Two lane unpaved (exc. 7,500 CY/Mi)	0.1	Mile	70,000	7,000
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Boat launching ramp unpaved Stab. aggr. (1,670 SY)	1	Job	L.S.	5,800
	Picnic sites	4	Ea.	590	2,360
	Portable Chemical Toilets	2	Ea	500	1,000
	Landscaping Development	1	Job	L.S.	1,520
	Subtotal Hallwood Area				21,480

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
14.	RECREATION FACILITIES (INITIAL) (Cont'd)				
	Recreation facilities Lower Yuba River (Cont'd)				
	Daguerre area				
	Access road incl. suppl. work Two lanes unpaved (exc. 7,500 CY/Mi)	1.4	Mile	70,000	98,000
	Parking area 60 cars unpaved Stab. aggr. (1,800 SY)	1	Job	L.S.	7,600
	Boat launching ramp unpaved Stab. aggr. (1,670 SY)	1	Job	L.S.	5,800
	Kiosk entrance	1	Job	L.S.	4,000
	Picnic sites	12	Ea.	590	7,080
	Portable chemical toilets	8	Ea.	500	4,000
	Water supply & dist. system	1	Job	L.S.	6,000
	Landscaping development	1	Job	L.S.	6,560
	Subtotal Daguerre Area				139,040
	Gold tailing area				
	Access road incl. suppl. work Two lanes unpaved (exc. 7,500 CY/Mi)	0.9	Mile	70,000	63,000
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Boat launching ramp unpaved Stab. aggr. (1,670 SY)	1	Job	L.S.	5,800
	Picnic sites	4	Ea.	590	2,360
	Portable chemical toilets	2	Ea.	500	1,000
	Landscaping development	1	Job	L.S.	1,520
	Subtotal Gold Tailing Area				77,480
	Subtotal				287,480
	Contingencies, 20% ±				52,520
	Total Recreation Facilities Lower Yuba River				340,000
	TOTAL RECREATION FACILITIES (INITIAL)				$1,000,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
18.	CULTURAL RESOURCES PRESERVATION				
	Demolition & site clearing, cleaning Brick & transportation	1	Job	L.S.	10,000
	Erection of replica of original structure (Wells Fargo Building at Timbuctoo) (Approx. 25' x 40')	1	Job	L.S.	100,000
	Raise Bridgeport covered wooden bridge & restore (230' lgt, raise 15')	1	Job	L.S.	335,000
	Archaeological & historical investigation and recovery	1	Job	L.S.	7,530,000
	Subtotal				7,975,000
	Contingencies, 20% ±				1,595,000
	TOTAL CULTURAL RESOURCES PRESERVATION				$9,570,000
19.	BUILDINGS, GROUNDS & UTILITIES				
	Administration area				
	Admin. office/visitor's center (Display area, 60 seat theater, offices, etc.)	10,000	S.Y.	40.00	400,000
	Residences	2	Ea.	42,000.00	84,000
	Parking area (asphalt paved, excavation 160 CY)	800	S.Y.	5.50	4,400
	Sidewalks & curbs	25	C.Y.	100	2,500
	Elec. power lines (3.8 miles)	1	Job	L.S.	225,000
	Telephone lines (1.9 miles)	1	Job	L.S.	40,000
	Water treatment plant & facilities	1	Job	L.S.	215,000
	Sewage disposal facilities	1	Job	L.S.	235,000
	Landscaping	1	Job	L.S.	25,000
	Subtotal Administration Area				1,230,900
	Overlook area				
	Overlook (pole type structure not inclosed, benches & display area approx. 600 S.F.)	1	Job	L.S.	25,000
	Restroom (4-fixture)	1	Job	L.S.	35,000
	Parking area (asphalt paved, excavation 2,800 CY)	975	S.Y.	17.50	17,063

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
19.	BUILDINGS, GROUNDS & UTILITIES (Cont'd)				
	Overlook area (Cont'd)				
	Water treatment plant & facilities	1	Job	L.S.	65,000
	Sewage disposal facilities	1	Job	L.S.	35,000
	Landscaping	1	Job	L.S.	5,000
	Subtotal Overlook Area				182,063
	Corporation Yard				
	Shop	1,500	S.F.	30.00	45,000
	Warehouse	1,875	S.F.	20.00	37,500
	Flammable storage	300	S.F.	25.00	7,500
	Chemical storage	308	S.F.	25.00	7,700
	Storage area (asphalt paved, excavation 37,000 CY)	10,000	S.Y.	17.50	175,000
	Subtotal Corporation Yard				272,700
	Powerplant area				
	Corporation yard (asphalt paved, excavation 750 CY)	3,750	S.Y.	7.30	27,375
	Water storage & distribution	1	Job	L.S.	25,000
	Sewage disposal facilities	1	Job	L.S.	25,000
	Subtotal Powerplant Area				77,375
	Subtotal				1,763,038
	Contingencies, 20% ±				336,962
	TOTAL BUILDINGS, GROUNDS & UTILITIES				$2,100,000
20.	PERMANENT OPERATING EQUIPMENT				
	Project tools & equipment	1	Job	L.S.	336,500
	Communication systems	1	Job	L.S.	410,000
	Maintenance truck crane	1	Job	L.S.	88,500
	Subtotal				835,000
	Contingencies, 20% ±				165,000
	TOTAL PERMANENT OPERATING EQUIPMENT				$1,000,000

TABLE IV - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
30.	ENGINEERING AND DESIGN				$ 49,400,000
31.	SUPERVISION AND ADMINISTRATION				$ 53,500,000 (a)
	TOTAL PROJECT FIRST COST (FEDERAL)				$961,000,000

(a) Excludes GSA-controlled bldg. space cost.

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TABLE V - ESTIMATE OF ANNUAL COST, STAGE II (Add 900 MW)
3-1/4% INTEREST
(1 October 1976 Price Level)
DAM AND RESERVOIR - FEDERAL

1. INVESTMENT COST

a.	First cost	$175,000,000
b.	Interest during construction	8,047,000
	(1) Yuba River Dam Powerplant (3 yrs x 3-1/4% x 1/2 x 1.145 x 127,900,000)	(7,139,000)
	(2) Afterbay Dam and Powerplant and Power Intake Works (2 yrs x 3-1/4% x 1/2 x 1.145 x 24,400,000)	(908,000)
c.	Gross (or net) investment	$183,047,000

2. ANNUAL COST

a.	Interest (3-1/4% x 1c)	5,949,000
b.	Amortization (100 yrs @ 0.00138 x 1c)	253,000
c.	Maintenance and operation	3,831,000
d.	Major replacements	546,000

3. TOTAL ANNUAL COST (FEDERAL) $10,579,000

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TABLE VI - ESTIMATE OF ANNUAL COST, STAGE II (Add 900 MW)
6-3/8% INTEREST
(1 October 1976 Price Level)

DAM AND RESERVOIR - FEDERAL

1.	INVESTMENT	
	a. First cost	175,000,000
	b. Interest during construction	15,785,000
	(1) Yuba River Dam Powerplant (3 yrs x 6-3/8% x 1/2 x 1.145 x 127,900,000)	(14,004,000)
	(2) Afterbay Dam and Powerplant and power intake works (2 yrs x 6-3/8% x 1/2 x 1.145 x 24,400,000)	(1,781,000)
	c. Gross (or net) investment	$ 190,785,000
2.	ANNUAL COST	
	a. Interest (6-3/8% x 1c)	12,163,000
	b. Amortization (100 yrs @ 0.00014 x 1c)	27,000
	c. Maintenance and operation	3,831,000
	d. Major replacements	292,000
3.	TOTAL ANNUAL COST (FEDERAL)	$ 16,313,000

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YUBA RIVER, CALIFORNIA
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TABLE VII - SUMMARY ESTIMATE OF FIRST COST, STAGE II (ADD 900 MW)

(1 October 1976 Price Level)

Cost Acct. No.	Feature	Subtotal $	Total $
	DAM AND RESERVOIR - FEDERAL		
04.	DAMS		23,100,000
	Power Intake Works	12,900,000	
	Afterbay Dam	10,200,000	
07.	POWERPLANT		129,200,000
	Powerplant Yuba River Dam	127,900,000	
	Powerplant Afterbay Dam	1,300,000	
08.	ROADS		240,000
19.	BUILDINGS GROUNDS AND UTILITIES		460,000
	SUBTOTAL		153,000,000
30.	ENGINEERING AND DESIGN		11,300,000
31.	SUPERVISION AND ADMINISTRATION		10,700,000 (a)
	TOTAL COST FEDERAL		$175,000,000

(a) Excludes GSA-controlled bldg. space cost.

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TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II (ADD 900 MW)
(1 October 1976 Price Level)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS				
	Main Dam (Yuba River Dam)				
	Power Intake Works				
	Trashracks	755,000	Lbs.	1.50	1,132,500
	Shutters	571,000	Lbs.	1.75	999,250
	Provision to bulkhead penstock (2 bulkheads)	1	Job	L.S.	10,000
	Mechanical				
	Penstock gates (26' W x 39.17' H x 340' Hd)	2	Ea.	3,000,000	6,000,000
	Penstock gate hoists and operating equipment	2	Set	1,000,000	2,000,000
	Subtotal				10,141,750
	Contingencies, 20% ±				2,028,250
	Subtotal				12,170,000
	Escalation to Midpoint of Construction				730,000
	Total Power Intake Works (Yuba River Dam)				$12,900,000
	Subtotal Main Dam (Yuba River Dam)				10,141,750
	Afterbay Dam				
	Earthen Portion				
	Clearing				
	Damsite	10	Ac.	870.00	8,700
	Borrow areas	10	Ac.	165.00	1,650

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Excavation and foundation work				
	Excavation				
	Foundation strip abutment				
	a. To Zone 4	14,000	C.Y.	1.10	15,400
	b. To waste	8,000	C.Y.	1.45	11,600
	Abutment core trench				
	a. To Zone 4	221,800	C.Y.	4.85	1,075,730
	b. To waste	11,700	C.Y.	5.20	60,840
	Foundation work				
	Dental fill				
	a. Concrete	100	C.Y.	65.00	6,500
	b. Cement	300	CWT	3.00	900
	Foundation drilling & grouting	129,000	L.F.	16.50	2,128,500

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Afterbay dam (Cont'd)				
	Earthen abutments				
	Excavation, borrow:				
	Strip and waste	34,300	C.Y.	1.35	46,305
	Impervious Zone 5	276,600	C.Y.	1.80	497,880
	Drain fill (processed) Zone 3	113,200	C.Y.	5.20	588,640
	Dredge tailings Zone 2	221,500	C.Y.	1.30	287,950
	Riprap Zone 6	40,000	C.Y.	9	360,000
	Embankment fill:				
	Impervious Zone 5	188,400	C.Y.	0.78	146,952
	Drain fill (processed) Zone 3	107,500	C.Y.	0.42	45,150
	Dredge tailings Zone 2	221,500	C.Y.	0.35	77,525
	Riprap Zone 6	40,000	C.Y.	0.30	12,000
	Transition Zone 4	271,200	C.Y.	0.74	200,688
	Road surfacing, guard rails, and lighting	10,900	L.F.	20	218,000
	Remove road (top of el. 258) (remove lighting, guard rails, & 28' rd.	1.3	Mile	25,000	32,500
	Beautification, landscaping, water quality control, and environmental consideration	1	Job	L.S.	170,000
	Subtotal - Earthen Portion				5,993,410
	Spillway				
	Piers and walls:				
	Concrete	7,860	C.Y.	90.00	707,400
	Cement	40,600	CWT	3.00	121,800
	Steel reinforcement	943,200	Lbs.	0.30	282,960
	Drilling, grouting, & doweling for walls and piers	1	Job	L.S.	20,000
	Upstream walls:				
	Concrete - formed	810	C.Y.	90.00	72,900
	Concrete - unformed	240	C.Y.	57.00	13,680
	Cement	5,420	CWT	3.00	16,260
	Steel reinforcement	126,000	Lbs.	0.30	37,800
	Spillway bridge (raising from el. 258 to el. 280) 5 spans @ 1,800 S.F. & 50,000 lbs. each	1	Job	L.S.	180,000
	Handrails	2,000	L.F.	20.00	40,000
	Beautification, landscaping, water quality control, and environmental consideration	1	Job	L.S.	45,000
	Subtotal - Spillway				1,537,800

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
04.	DAMS (Cont'd)				
	Afterbay Dam (Cont'd)				
	Gates and associated items				
	Top seal for tainter gates (53.5'W x 59' H)	1	Job	L.S.	10,000
	Relocate Tainter gate hoists - incl. oper. equip. (53.5' W x 59' H)	5	Ea.	50,000	250,000
	Modify Tainter gate hoists - incl. oper. equip. (8.5' W x 15' H)	1	Ea.	27,500	27,500
	Bulkhead guides & misc.	1	Ea.	8,500	8,500
	Electrical	1	Job	L.S.	50,000
	Painting, testing, etc.	1	Job	L.S.	50,000
	Extension of stop log slot guides	1	Job	L.S.	50,000
	Subtotal - Gates & Associated Items				446,000
	Subtotal Earthen Portion				5,993,410
	Subtotal Spillway				1,537,800
	Subtotal				7,977,210
	Contingencies, 20% ±				1,602,790
	Subtotal				9,580,000
	Escalation to Midpoint of Construction				620,000
	Total Afterbay Dam				$10,200,000
	TOTAL DAMS				$23,100,000

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT				
.1	Powerhouse				
	Excavation				
	Building:				
	Common	28,200	C.Y.	1.10	31,020
	Rock	88,300	C.Y.	5.50	485,650
	Close line drilling - presplit	35,200	S.F.	1.20	42,240
	Parking & building access:				
	Common	252,400	C.Y.	1.10	277,640
	Rock	41,200	C.Y.	5.50	226,600
	Close line drilling - presplit	39,400	S.F.	1.20	47,280
	Foundation preparation	3,500	S.Y.	6.50	22,750
	Backfill and grading	272,400	C.Y.	3.25	885,300
	Removal, modification and replacement of existing roads, parking, etc.	1	Job	L.S.	1,000,000
	Penstocks				
	A537 (can)	3,757,300	Lbs.	1.05	3,945,165
	A36 (stiffeners)	171,900	Lbs.	1.65	283,635
	Concrete	12,500	C.Y.	130.00	1,625,000
	Cement	64,500	CWT	3.00	193,500
	Steel reinforcement	1,875,000	Lbs.	0.30	562,500
	Building (170.5' x 226') (1 pump turbine bay & erection bay)	1	Job	L.S.	7,786,000
	Draft tube equipment				
	Pump turbine units				
	Draft tube gate (3-35' W x 32' H x 195 HD)	3	Job	290,000	870,000
	Draft tube gate guides	1	Set	122,700	122,700
	Misc. metal, etc.	1	Job	L.S.	1,553,400
	Beautification, landscaping, water quality control, and environmental considerations	1	Job	L.S.	580,000
	Subtotal				20,540,380
	Contingencies, 20% ±				4,109,620
	Subtotal				24,650,000
	Escalation to Midpoint of Construction				2,250,000
	Total Powerhouse				$26,900,000

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT (Cont'd)				
.2	Turbines and generators				
	Pump turbine units:				
	Turbines	2	Ea.	12,950,000	25,900,000
	Governors	2	Ea.	190,000	380,000
	Motor generators	2	Ea.	6,310,000	12,620,000
	Butterfly valves & oper.	2	Ea.	10,000,000	20,000,000
	Subtotal				58,900,000
	Contingencies, 20% ±				11,800,000
	Subtotal				70,700,000
	Escalation to Midpoint of Construction				6,400,000
	Total Turbines and Generators				$77,100,000
.3	Switchyard accessory, miscellaneous powerplant equipment, and tailrace				
	Switchyard equipment	1	Job	L.S.	4,500,000
	Mechanical items:				
	Misc. mechanical equipment and accessories	1	Job	L.S.	6,370,000
	Electrical items:				
	Power transformers	1	Job	L.S.	1,570,000
	Misc. electrical equipment and accessories	1	Job	L.S.	3,710,000
	Tailrace				
	Excavation:				
	Common	228,300	C.Y.	1.65	376,695
	Rock	221,600	C.Y.	5.50	1,218,800
	Close line drilling - presplit	31,900	S.F.	1.20	38,280
	Drilling & grouting for anchor bars	3,900	L.F.	9.25	36,075
	Concrete	2,350	C.Y.	1.30	305,500
	Cement	12,100	CWT	3.00	36,300
	Steel reinforcement	216,200	Lbs.	0.30	64,860
	Beautification, landscaping, water quality control, and environmental considerations	1	Job	L.S.	60,000

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
07.	POWERPLANT (Cont'd)				
.3	Switchyard accessory, miscellaneous powerplant equipment, and tailrace (Cont'd)				
	Subtotal				18,286,510
	Contingencies, 20% ±				3,663,490
	Subtotal				21,950,000
	Escalation to Midpoint of Construction				1,950,000
	Total Switchyard Accessory, Miscellaneous Powerplant Equipment, and Tailrace				$23,900,000
	TOTAL POWERPLANT MAIN DAM				$127,900,000
07.A	AFTERBAY POWERPLANT				
	Add concrete extension at intake	3,900	C.Y.	240.00	936,000
	Cement	20,000	CWT	3.00	60,000
	Steel reinforcement	46,000	Lbs.	0.30	13,800
	Extend intake trashrack guides	1	Job	L.S.	10,000
	Extend intake gate guides	1	Job	L.S.	3,000
	Subtotal				1,022,800
	Contingencies, 20% ±				207,200
	Subtotal				1,230,000
	Escalation to Midpoint of Construction				70,000
	TOTAL AFTERBAY POWERPLANT				$1,300,000
08.	ROADS				
	Access road to hatchery (part new, part to be surfaced)	2	Mile	100,000	200,000
	Contingencies, 20% ±				40,000
	TOTAL ROADS				$ 240,000
19.	BLDGS., GROUNDS & UTILITIES				
	Temporary construction facilities & structural modifications	1	Job	L.S.	400,000
	Contingencies, 20% ±				60,000
	TOTAL BLDGS., GROUNDS & UTILITIES				$ 460,000

TABLE VIII - ESTIMATE OF PROJECT FIRST COST, STAGE II - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
30.	ENGINEERING AND DESIGN				$11,300,000
31.	SUPERVISION AND ADMINISTRATION				$10,700,000 (a)
	TOTAL FIRST COST STAGE II (FEDERAL)				$175,000,000

(a) Excludes GSA-controlled bldg. space cost.

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TABLE IX - ESTIMATE OF ANNUAL COST
RECREATION FACILITIES FUTURE
3-1/4% INTEREST
(1 October 1976 Price Level)

1.	INVESTMENT COST	
	a. First cost	290,000
	b. Interest during construction	-
	c. Gross (or net) investment	$290,000
2.	ANNUAL COST	
	a. Interest (3-1/4% x 1c)	9,400
	b. Amortization (100 yrs @ 0.00138 x 1c)	400
	c. Maintenance and operation	26,000
3.	TOTAL ANNUAL COST (FEDERAL)	$ 35,800

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TABLE X - ESTIMATE OF ANNUAL COST
RECREATION FACILITIES FUTURE
6-3/8% INTEREST
(1 October 1976 Price Level)

1.	INVESTMENT COST	
	a. First Cost	290,000
	b. Interest during construction	-
	c. Gross (or net) investment	$290,000
2.	ANNUAL COST	
	a. Interest (6-3/8% x 1c)	18,500
	b. Amortization (100 yrs @ 0.00014 x 1c)	-
	c. Maintenance and operation	26,000
3.	TOTAL ANNUAL COST (FEDERAL)	$ 44,500

MARYSVILLE LAKE
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TABLE XI - SUMMARY ESTIMATE OF FIRST COST
RECREATION FACILITIES FUTURE
(1 October 1976 Price Level)

Cost: Acct: No	Feature	Subtotal	Total $
14.	RECREATION FACILITIES (FUTURE)		240,000
30.	ENGINEERING AND DESIGN		30,000
31.	SUPERVISION AND ADMINISTRATION		20,000 (a)
	TOTAL RECREATION FACILITIES FUTURE (FEDERAL)		$290,000

(a) Excludes GSA-controlled bldg. space cost.

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TABLE XII - ESTIMATE OF PROJECT FIRST COST
RECREATION FACILITIES FUTURE
(1 October 1976 Price Level)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
14.	RECREATION FACILITIES (FUTURE)				
	Recreation facilities Lower Yuba River				
	River mouth area				
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Picnic sites	4	Ea.	590.00	2,360
	Portable chemical toilets	2	Ea.	500.00	1,000
	Landscaping development	1	Job	L.S.	1,520
	Subtotal River Mouth Area				8,680
	Simpson Lane area				
	Access road incl. suppl.work Two lanes unpaved (exc. 7,500 CY/Mi)	1.2	Mile	70,000	84,000
	Parking area 50 cars unpaved Stab. aggr. (1,500 SY)	1	Job	L.S.	7,600
	Boat launching ramp unpaved Stab. aggr. (750 SY)	1	Job	L.S.	5,800
	Picnic sites	8	Ea.	590.00	4,720
	Portable chemical toilets	4	Ea.	500.00	2,000
	Landscaping development	1	Job	L.S.	3,040
	Subtotal Simpson Lane Area				107,160
	River Bend area				
	Access road incl. suppl. work Two lanes unpaved (exc. 7,500 CY/Mi)	0.3	Mile	70,000	21,000
	Parking area 50 cars unpaved Stab. aggr. (1,500 SY)	1	Job	L.S.	7,600
	Boat launching ramp unpaved Stab. aggr. (750 SY)	1	Job	L.S.	5,800
	Picnic sites	8	Ea.	590.00	4,720
	Portable chemical toilets	4	Ea.	500.00	2,000
	Landscaping development	1	Job	L.S.	3,040
	Subtotal River Bend Area				44,160

TABLE XII - ESTIMATE OF PROJECT FIRST COST - (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price $	Amount $
14.	RECREATION FACILITIES (FUTURE) (Cont'd)				
	Hallwood area				
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Picnic sites	4	Ea.	590.00	2,360
	Portable chemical toilets	2	Ea.	500.00	1,000
	Landscaping development	1	Job	L.S.	1,520
	Subtotal Hallwood Area				8,680
	Daguerre area				
	Parking area 60 cars unpaved Stab. aggr. (1,800 SY)	1	Job	L.S.	9,000
	Picnic sites	12	Ea.	590.00	7,080
	Portable chemical toilets	6	Ea.	500.00	3,000
	Landscaping development	1	Job	L.S.	4,560
	Subtotal Daguerre Area				23,640
	Gold tailing area				
	Parking area 25 cars unpaved Stab. aggr. (750 SY)	1	Job	L.S.	3,800
	Picnic sites	4	Ea.	590.00	2,360
	Portable chemical toilets	2	Ea.	500.00	1,000
	Landscaping development	1	Job	L.S.	1,520
	Subtotal Gold Tailing Area				8,680
	Subtotal				201,000
	Contingencies, 20% ±				39,000
	TOTAL RECREATION FACILITIES (FUTURE)				$ 240,000
30.	ENGINEERING AND DESIGN				30,000
31.	SUPERVISION AND ADMINISTRATION				20,000 (a)
	TOTAL COST (FEDERAL)				$ 290,000

(a) Excludes GSA-controlled bldg. space cost.

YUBA RIVER, CALIFORNIA

GENERAL DESIGN MEMORANDUM

PHASE I

APPENDIX N
SECTION 404 EVALUATION REPORT

APPENDIX N - SECTION 404 EVALUATION REPORT

Table of Contents

APPENDIX N - SECTION 404 EVALUATION REPORT

1. Introduction. -

In accordance with 33 CFR 209, 40 CFR 230, Section 404 of the Federal Water Pollution Control Act, and other pertinent laws and regulations, the placement of fill material in a navigable waterway by the Corps of Engineers requires an evaluation of impacts associated with the action.

Construction of Marysville Lake project will require excavation of material from within and adjacent to the Yuba River and Dry Creek in the vicinity of the main Yuba River dam at Parks Bar and the afterbay dam at Long Bar on the Yuba River and Dry Creek dam on Dry Creek. This material will be used to build the three dams. Construction of the project also will result in placing fill material in and adjacent to the Yuba River and Dry Creek.

2. Purpose. -

The purpose of this appendix is to report on environmental factors pertinent to the 404 evaluation process that are affected by the project and to provide references to paragraphs in which these factors are discussed in the Phase I General Design Memorandum, Environmental Statement, and other documents. The appendix also identifies public participation actions taken to fully inform the public about the project and its impact on factors and criteria included in the 404 evaluation.

3. Environmental assessment. -

The following paragraphs identify (a) pertinent environmental factors which should be considered for the Marysville Lake project under Section 404 of the Federal Water Pollution Control Act, (b) referenced paragraphs of documents in which the factors are analyzed or discussed, and (c) remarks which indicate the need for any additional analyses.

a. Fishery resources.

(1) Factors considered. - Detailed fishery studies have been conducted by the Corps of Engineers, State and Federal fish and wildlife agencies, and an expert consultant to identify the existing resource and project what would occur in the future with and without Marysville Lake project. Studies have shown that features implemented as part of the project, such as downstream flow requirements, controlled water temperature releases by means of a multiple-level intake, and acquisition of riparian lands and spawning gravel areas below the afterbay dam, would mitigate losses due to the project. In addition, an enhancement potential of 70,000 salmon and 10,000 steelhead exists with the project through hatchery construction and gravel management techniques on the Yuba River below the afterbay. Also, a new warm- and cold-water fishery would be created at the lake.

(2) References.

Draft EIS

Environmental Setting Without the Project - Fishery resources, paragraph 2.01.01.12.

Probable Impact of the Proposed Action on the Environment - Impacts on fishery resources, paragraph 4.01.01.09.

Phase I GDM

Problems and Needs - Fish and wildlife enhancement, paragraph 4-5.

Investigations - Fish and wildlife, paragraph 7-8.

The Selected Plan - Fish enhancement, paragraph 9-16 and Fish and wildlife mitigation, paragraph 9-17.

Economics of the Selected Plan - Benefits, paragraph 10-2.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix D - Recreation Resources - Fish and Wildlife Management Programs - Fishery resources, mitigation, and enhancement, paragraph 33, and Fish and wildlife monitoring and analysis, paragraph 38.

Appendix E - Environmental Setting - Natural environment, paragraph 1.

Appendix L - Basis of Design of Selected Plan - Fish and wildlife facilities, paragraph 21.

Beak Consultants, Inc.

Benefits and Impacts of the Marysville Lake Project on Fish and Wildlife, Summer 1976 - See numerous data throughout.

(3) Remarks. - Fish monitoring and analysis will be conducted before and after the project is constructed to identify contributions to each of the mitigation and enhancement features implemented. Data gathered

will be used to modify, if necessary, the fishery mitigation and enhancement program.

b. Wildlife resources.

(1) Factors considered. - Studies conducted by the Corps of Engineers, State and Federal fish and wildlife agencies, and an expert consultant indicate that there will be a significant loss of wildlife habitat as a result of the project. The Corps of Engineers is recommending a mitigation program to offset project-related losses by habitat improvements to increase wildlife carrying capacity and by preserving nearby habitat areas threatened by land use change. The measures recommended would utilize about 16,000 acres of land.

(2) References.

Draft EIS

Environmental Setting Without the Project - Wildlife resources, paragraph 2.01.01.11.

Probable Impact of the Proposed Action on the Environment - Impacts on wildlife resources, paragraph 4.01.01.08.

Phase I GDM

Problems and Needs - Fish and wildlife enhancement, paragraph 4-5.

Investigations - Fish and wildlife, paragraph 7-8.

The Selected Plan - Fish and wildlife mitigation, paragraph 9-17.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix D - Recreation Resources - Fish and Wildlife Management Programs - Wildlife resources, paragraph 34, Wildlife mitigation plan, paragraph 35, and Fish and wildlife monitoring and analysis, paragraph 38.

Appendix E - Environmental Setting - Natural environment, paragraph 1.

Appendix L - Basis of Design of Selected Plan - Fish and wildlife facilities, paragraph 21.

Beak Consultants, Inc.

Benefits and Impacts of the Marysville Lake Project on Fish and Wildlife, Summer 1976 - See numerous data throughout.

(3) Remarks. - The numbers of wildlife in the project area in studies to date are preliminary estimates but are the best available. Mitigation measures have been developed on these preliminary estimates, and further studies will be conducted to confirm or change the estimates as appropriate. If population estimates are modified, adjustments will be made in the planned mitigation program.

c. Vegetation.

(1) Factors considered. - Detailed studies have been conducted to identify the various vegetative types impacted by the project. These studies show that about 6,260 acres of various types of vegetative communities will be inundated or altered due to construction and operation activities. These aspects are closely related to wildlife impacts in that wildlife are dependent on a variety of vegetative types. The primary

measures to mitigate vegetative losses consist of vegetative improvements through plantings and management, acquisition and management of key vegetative types such as riparian vegetation, and creation of vegetative types which are endangered due to land use conversions, i.e., small detention ponds with associated marsh vegetation.

(2) References.

Draft EIS

Environmental Setting Without the Project - Vegetation, paragraph 2.01.01.06.

Probable Impact of the Proposed Action on the Environment - Impacts on vegetation, paragraph 4.01.01.03.

Phase I GDM

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix D - Recreation Resources - Fish and Wildlife Management Programs - Wildlife resources, paragraph 34, Wildlife mitigation plan, paragraph 35, and Fish and wildlife monitoring and analysis, paragraph 38.

Appendix E - Environmental Setting - Natural environment, paragraph 1.

Beak Consultants, Inc.

Benefits and Impacts of the Marysville Lake Project on Fish and Wildlife, Summer 1976 - See numerous data throughout.

(3) Remarks. - As indicated in the wildlife discussion, acquisition, improvements, and modifications of vegetative types planned for the project are based on preliminary estimates of wildlife numbers.

Further studies on the relationship of numbers of wildlife and their habitat needs will be conducted to identify what vegetative programs are required to mitigate adverse impacts.

d. Cultural resources.

(1) Factors considered. - A reconnaissance cultural resources survey of the project area was conducted in 1974 and an intensive cultural and ethnographic survey was conducted in 1976. Based on these studies, there are about 430 archeological and historical sites in the project area, of which 245 sites would be inundated. One site, Bridgeport Covered Bridge, is currently on the National Register of Historic Places, and additional sites may be eligible based on data prepared to date. The Corps of Engineers would take appropriate actions to protect or mitigate project-related impacts as directed by Executive Order 11593, Public Law 93-291, and other related laws and regulations.

(2) References.

Draft EIS

Environmental Setting Without the Project - Cultural resources, paragraph 2.01.01.14.

Probable Impact of the Proposed Action on the Environment - Impacts on cultural resources, paragraph 4.01.01.11.

Phase I GDM

Investigations - Cultural resources, paragraph 7-9.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix D - Recreation Resources - Description of Project Area - Cultural resources, paragraph 11.

Appendix E - Environmental Setting - Natural environment, paragraph 1.

Appendix L - Basis of Design of Selected Plan - Cultural resources restoration and preservation, paragraph 16.

Cultural Resources Reports

An Archeological Site Survey of Selected Portions of the Proposed Parks Bar Dam Project Alternate, Yuba River, California, 1974 - See numerous data throughout.

An Anthropological Study of the Parks Bar Alternate of the Marysville Lake Project, Nevada and Yuba Counties, California, 1976 - See numerous data throughout.

(3) Remarks. - Continued coordination of cultural resources aspects will be maintained with National Park Service, State Historic Preservation Office, and others with an interest in cultural resources in the project area. The Corps, with input from agencies and authoritative individuals, will determine whether to nominate any sites for inclusion in the National Register of Historic Places. In addition, a mutually acceptable plan for protection and/or mitigative measures will be developed through a Memorandum of Agreement coordinated with the Advisory Council on Historic Preservation and the State Historic Preservation Office. Once this agreement is signed, the protective and mitigative program will be implemented.

e. Water quality.

(1) Factors considered. - Impacts of construction and operation of the project have been analyzed, and no significant water quality problems are foreseen. During construction, temporary water quality problems could occur, although water diversion facilities, sediment ponds, and other measures would be taken to reduce adverse effects. In addition, all construction activities would be coordinated with State and Federal water quality agencies, and construction specifications would include provisions for controlling water quality during construction. A multilevel intake structure is included in the project to permit selective withdrawal of water for downstream releases at specified temperatures. Downstream water quality is expected to be essentially unchanged by the project; however, quality should be improved when periods of low flow would have occurred without the project and flows would be increased with the project in operation. Studies conducted to date indicate that no significant water quality problems are anticipated at the lake based on scheduled operation criteria.

(2) References.

Draft EIS

Environmental Setting Without the Project - Benthic organisms and water quality, paragraph 2.01.01.10.

Probable Impact of the Proposed Action on the Environment - Impacts on benthic organisms and water quality, paragraph 4.01.01.07.

Phase I GDM

Investigations - Water quality and heavy metals, paragraph 7-3.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix G - Water Quality and Heavy Metals - See numerous data throughout.

Beak Consultants, Inc.

Mercury, Lead, and Boron Levels in the Vicinity of the Marysville Lake, California, Project, March 1976 - See numerous data throughout.

Waterways Experiment Station

Draft - Technical Report - Marysville Lake Hydro-Thermal Study, October 1976 - See numerous data throughout.

(3) Remarks. - Water quality monitoring and associated studies will continue, and the results will appear in future Design Memorandums. A construction and project operation monitoring program would be implemented, and details of the program will be discussed in the Phase II GDM.

f. Benthic organisms.

(1) Factors considered. - Available data indicate that benthic organisms would be eliminated in the Yuba River where dams would displace the aquatic environment. Lotic (stream related) benthic organisms would also be eliminated in the streams inundated by the project. The lake would provide new habitat for lentic (standing water) benthic organisms

in areas where dissolved oxygen levels or other factors would not preclude their existence. It is anticipated that benthic organisms in the Yuba River below the afterbay would be unchanged, or perhaps increased somewhat due to improved flows and water quality.

(2) References.

Draft EIS

Environmental Setting Without the Project - Benthic organisms and water quality, paragraph 2.01.01.10.

Probable Impacts of the Proposed Action on the Environment - Impacts on benthic organisms and water quality, paragraph 4.01.01.07

(3) Remarks. None.

g. Fill materials.

(1) Factors considered. - Studies conducted to date indicate the fill material used to construct the dams and dikes would not create any significant adverse effects on chemical changes, toxicity, or other factors. About 1,000 acres would be disturbed to obtain material, primarily from areas below gross pool elevation, to form the impervious zone of the dams, and about 1,800 acres of dredge tailings would be disturbed to obtain material to cover the earthfill core. Studies conducted by a consultant indicate that excavation and placing of dredge tailings would not introduce significant levels of mercury, boron, or lead in the impounded area or the Yuba River below the afterbay. Some elemental mercury from localized deposits could enter the aquatic

environment in excavating the dredge tailings, although the mercury would be rapidly bound to suspended particulates and rapidly removed from the aquatic environment by precipitation. No temporary increases in lead or boron due to excavation are anticipated.

(2) References.

Draft EIS

Environmental Setting Without the Project - Benthic organisms and water quality, paragraph 2.01.01.10.

Probable Impacts of the Proposed Action on the Environment - Impacts on benthic organisms and water quality, paragraph 4.01.01.07.

Phase I GDM

Investigations - Water quality and heavy metals, paragraph 7-3.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix G - Water Quality and Heavy Metals - See numerous data throughout.

Beak Consultants, Inc.

Mercury, Lead, and Boron Levels in the Vicinity of the Marysville Lake, California, Project, March 1976 - See numerous data throughout.

(3) Remarks. - See remarks under water quality.

h. Air quality.

(1) Factors considered. - Air quality influences would be increased during construction and operation of the project. These increases would result from equipment operation, dust, smoke from reservoir clearing operations, auto traffic, and secondary services related to the influx of people during construction. During operation of the project, recreation and fish and wildlife developments would increase automobile traffic and associated services in the project area. Standard contract provisions of the Corps of Engineers provide for adequate control of air pollution from construction sources, and it is expected that Federal, State, and local regulation of air quality controls would continue to abate unacceptable levels of air pollutants during operation of the project.

(2) References.

Draft EIS

Environmental Setting Without the Project - Air quality, paragraph 2.01.01.08.

Probable Impacts of the Proposed Action on the Environment - Impacts on air quality, paragraph 4.01.01.05.

Phase I GDM Appendixes

Appendix E - Environmental Setting - Natural environment, paragraph 1.

(3) Remarks. None.

i. Aesthetics.

(1) Factors considered. - The present landscape of streams, a small lake, rolling hills, trees and grassland, dredge tailings, and scattered houses would be replaced by a large lake, afterbay, powerplants and associated operation facilities. Design features would be incorporated to emphasize compatibility of the project with the natural surroundings, identification with the cultural environment, cohesion of the project by incorporating recognizable features throughout, and general coordination of the various project features. Landscaping and restoration of construction areas would also be implemented.

(2) References.

Draft EIS

Environmental Setting Without the Project - Scenic setting, paragraph 2.01.01.13.

Probable Impact of the Proposed Action on the Environment - Impacts on scenic and visual qualities, paragraph 4.01.01.10.

Phase I GDM

The Selected Plan - Beautification, paragraph 9-20.

Other Impacts of the Selected Plan - Impacts on natural conditions, paragraph 11-2.

Phase I GDM Appendixes

Appendix L - Basis of Design of Selected Plan - Beautification, paragraph 27.

(3) Remarks. - The Corps of Engineers would prepare two master plans for the project. One would cover the entire project, except developments along the lower Yuba River, to identify measures to enhance the aesthetic appeal and to guide development and public use as well as conservation of natural resources. The second master plan would cover the recreation and natural resources and improvements for recreation and fish and wildlife along the lower Yuba River and would provide guidelines for development, public use, administration, and conservation of the aesthetic, recreation, and fish and wildlife resources.

j. Recreation.

(1) Factors considered. - Fishing, hunting, canoeing, swimming, camping, and other outdoor recreation activities occur in the project area although public access and support facilities are limited. The project would provide public access to the lake and lower Yuba River area. In addition, facilities would be developed to accommodate this use.

(2) References.

Draft EIS

Environmental Setting Without the Project - Recreation resources, paragraph 2.01.01.18.

Probable Impact of the Proposed Action on the Environment - Impacts on recreation resources, paragraph 4.01.01.15.

Phase I GDM

Problems and Needs - General recreation, paragraph 4-4.

Investigations - General recreation, paragraph 7-7.

The Selected Plan - Recreation, paragraph 9-15.

Economics of the Selected Plan - Benefits, paragraph 10-2.

Phase I GDM Appendixes

Appendix D - Recreation Resources - See numerous data throughout.

Appendix L - Basis of Design of Selected Plan - Recreation facilities, paragraph 20.

(3) Remarks. - See remarks under Aesthetics.

4. Public involvement and coordination. -

The following identifies public involvement and coordination activities for the Marysville Lake project at the Parks Bar site.

a. Public notices. - In February 1968, advance engineering and design studies for the project were initiated and a Notice of Initiation was issued. A news release regarding the change in focus of Phase I GDM studies to the Parks Bar site was issued in April 1975.

b. Public meetings. - Numerous public meetings have been held throughout Phase I GDM studies, as discussed in Section VIII of the GDM. The latest formal public meetings were held in April 1975 and November

1976 to discuss the status of the project and studies conducted to date, including environmental factors and criteria included in this appendix.

c. Environmental impact coordination. - An Environmental Working Paper (a predraft environmental statement) was distributed for informal review and comments in July 1976. The working paper identified environmental impacts of the project and was sent to Federal, State, and local agencies, organizations, and individuals, many of which are environmentally oriented. Comments obtained were incorporated into the draft Environmental Statement (EIS). A final EIS will be prepared, based on comments received on the draft.

d. Other coordination. - Close coordination has been maintained throughout the Phase I GDM studies with U.S. Fish and Wildlife Service, National Marine Fisheries Service, California Department of Fish and Game, and others to identify environmental impacts and measures to avoid, mitigate, or enhance project-related activities. This input has been very useful and many measures recommended have been incorporated in the project. Several informal workshop-type meetings were held with members of the Sierra Club, Mother Lode Chapter, concerning environmental quality aspects, to obtain views and suggestions which have been utilized in preparing the GDM and EIS. Close coordination will continue in Phase II - Design studies.

5. Conclusions. -

Based on studies and coordination conducted during the Phase I GDM investigation, environmental factors pertinent to the Section 404 evaluation process have been considered. Additional studies and coordination would be conducted during the Phase II GDM studies to confirm or modify plans developed to date.

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ADB344304 • Lemon Reservoir Florida River, Colorado. Report on reservoir regulation for flood control, July 1974
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ADB344346 New Hogan Dam and Lake, Calaveras River, California. Water Control Manual Appendix III to Master Water Control Manual San Joaquin River Basin, California, July 1983
ADB344307 • Special Flood Hazard Study Nephi, Utah, November 1998 (cataloged)
ADB344344 • Special Study on the Lower American River, California, Prepared for US Bureau of Reclamation – Mid Pacific Region and California Dept. of Water Resources..., March 1987
ADB344313 Transcript of public meeting Caliente Creek stream group investigation, California, held by, the Kern County Water Agency in Lamont, California, 9 July 1979
ADB344302 • Initial appraisal Sacramento River Flood control project (Glenn-Colusa), California, 10 February 1989
ADB344485 • Report on November-December 1950 floods Sacramento-San Joaquin river basins, California and Truckee, Carson, and Walker rivers, California and Nevada, March 1951
ADB344268 • Reexamination Little Dell Lake, Utah, February 1984
ADB344197 • Special report fish and wildlife plan Sacramento River bank protection project, California, first phase, July 1979
ADB344264 • Programmatic environmental impact statement/environmental impact report Sacramento River flood control system evaluation, phases II-V, May 1992
ADB344201 • Hydrology office report Kern river, California, January 1979
ADB344198 • Kern River – California aqueduct intertie, Kern county, California, environmental statement, February 1974
ADB344213 • Sacramento river Chico Landing to Red Bluff, California, bank protection project, final environmental statement, January 1975
ADB344265 • Cottonwood Creek, California, Information brochure on selected project plan, June 1982
ADB344261 • Sacramento river flood control project Colusa Trough Drainage Canal, California, office report, March 1993
ADB344343 • Detailed project report on Kern River-California aqueduct intertie, Kern County, California, February 1974

- ADB344267 Sacramento River Flood Control Project, California, Right Bank Yolo Bypass and Left Bank Cache Slough near Junction Yolo Bypass and Cache Slough, Levee construction, General Design, Supplement No. 1 to Design Memorandum #13, May 1986
- ADB344246 Redbank and Fancher Creeks, California, General Design Memorandum #1, February 1986
- ADB344260 Cache Creek Basin, California, Feasibility report and environmental statement for water resources development Lake and Yolo counties, California, February 1979
- ADB344199 Sacramento River Deep Water Ship channel, California, Feasibility report and environmental impact statement for navigation and related purposes, July 1980
- ADB344263 Sacramento River flood control project, California, Mid-Valley area, phase III, Design Memorandum, Vol. I or II, June 1986
- ADB344262 Marysville Lake, Yuba River, California, General Design Memorandum Phase I, Plan Formulation, Preliminary Report, Appendixes A-N, Design Memorandum #3, March 1977

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